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☞ An asterisk (*) denotes an illustrated article

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WISHING TO MAKE THIS JOURNAL an organ of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, the publishers solicit letters from all among them who make the study of these subjects a pleasure, or a profession.

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NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.

BOSTON, Jan. 1, 1877.

The Annual Meeting of the Association will be held at the Tremont House, Boston, on Wednesday, February 21, 1877, at 10 o'clock, A. M.

GEO. B. NEAL,
Secretary.

GAS STOVE ACCIDENTS.

Within the past few weeks there have been two fatal accidents resulting from the improper use of gas stoves in the city of Providence, Rhode Island. Naturally these two events have caused some excitement, and a good deal of newspaper discussion, in the locality where they occurred; and we deem it of sufficient importance to call the attention of our readers to the facts in the case, in order that they may, knowing them, guard against any similar fatal results which are sure to follow from the same misuse of what we believe to be a most useful article, and, when used with anything like the same caution that attends the use of a common coal stove, a perfectly safe one. The peculiar construction of the stove in question has fortunately nothing to do with the case, and it is said that every effort had been made to render the stove perfectly free from smoke or smell, and, when used with ordinary care, perfectly safe.

The first case was that of a Mr. Shattuck, who employed a gas stove for the purpose of heating a bathroom. In order to bring the room to a comfortable temperature the stove was lighted for an hour before he entered for the purpose of bathing, and was probably "turned on full," so that at the time he began to bathe the room must have been full of the products of imperfect combustion. After having been in the room for some time the fact of his not coming out was noticed by the family. Upon investigation he was found on the floor dead.

The other case was that of a woman who visited the office of a female doctor for medical advice, and after waiting in the room for a little while suddenly dropped dead. Upon physicians being called they at once found the air of the room exceedingly difficult to breathe, and ordered the opening of windows, etc., before any examination could be made. The office was heated by a gas stove. A post mortem examination showed that death, in both cases, resulted from poisoning by carbonic oxide—the characteristics of which are very marked, and differ entirely from asphyxia or suffocation from carbonic acid gas.

In the case of Mr. Shattuck there was an exceptionally high pressure at the point where his house stood. The stove was intended, under ordinary pressure, to burn from 12 to 15 feet per hour, but was so constructed that it would carry 20 feet per hour with perfect combustion. If, when the gas was lighted, the stop cock had been only partially opened there would have been no trouble, and the smell from the stove should have been enough to show that something was wrong. At a trial made subsequently, by turning the full head of gas on to the stove, and watching the meter, it was found that 30 feet an hour were passing through the stove, that the combustion was imperfect, and the odor very apparent. Here was the whole trouble. The atmosphere of the room was not poisoned by the consumption of the oxygen in burning the hydrogen, but it was the result of the decomposition of water and carbonic acid gas—the natural products of perfect combustion—into hydrogen and *carbonic oxide* gases. Every one knows the impossibility of providing against every accident, even in the most perfect mechanism; and when we reflect that there are authenticated cases where people have deliberately *blown out* the gas, and gone to bed seemingly unconscious of the odor resulting therefrom, it is evident that it is not safe to rely entirely upon the sense of smell to protect life.

In this case very similar conditions would have resulted if, instead of a gas stove, there had been a coal stove in the room, and it had been well filled to the top with anthracite, and particular care taken to shut the damper in the chimeney flue as tight as possible; yet this is no argument against the use of anthracite coal for heating purposes. Every machine must be operated with some regard to the objects for which it was constructed, or disastrous results will follow. In this case, besides the imperfect combustion due to over supply, there was another item, viz., the *lack of ventilation*. To show what were the effects of the two combined we give the following:

"Drs. J. B. and Williard H. Greene have made another experiment for the purpose of ascertaining more fully the causes which led to the death of Mr. E. L. Shattuck. The latest experiment, like the preceding one, was made with pigeons, and the results confirm both doctors in their opinion that Mr. Shattuck's death was caused by carbonic oxide produced in fatal amount by an oversupply of gas and a lack of ventilation in the room. In the latest experiment, after a fire had burned in the gas stove in the bath-room for an hour, three pigeons were placed in the room. One was put upon the floor, one upon a bed, and

one hung upon the wall at the height of a man's face. The thermometer stood at 60°, and a pane of glass inserted in the door allowed the motions of the pigeons to be watched. In about ten minutes the pigeon on the floor and the one on the bed thrust their heads out of their cages, while the one hanging against the wall retired to the corner of its cage and remained motionless for about twenty minutes, when it gave a convulsive flutter and moved no more. In fifty minutes from the time it was placed in the room, the pigeon on the bed struggled a little and died. The pigeon on the floor was at times a little uneasy, but at the end of five hours it seemed to have no thought of dying. It was then put in the cage on the wall, where it only lived a short time. A post mortem examination of each pigeon showed no marked symptoms of inflammation of the brain or its membranes. The heart of the bird that died on the bed showed an engorgement of blood and a clot in one of the ventricles. The lungs of each bird had a pinkish hue, similar to that worn by Mr. Shattuck's lungs after death, and usually found in cases where death has been caused by carbonic oxide gas. Portions of the lungs bore the appearance of curdled milk mingled with blood. The heart and lungs of the bird that lived the longest bore evidence of a high degree of congestion. He had not, however, disgorged the contents of his crop and retained considerable undigested food. From these and other appearances, the death of the pigeons was attributed to carbonic oxide. The practical point of the matter is in regard to the safety of using gas stoves. What happened with the retort stove would probably have happened with any gas stove. The safeguards are abundant ventilation and care that the stove receives no more gas than it is able to consume. If a stove will burn 20 feet of gas an hour, the supply should be regulated at the meter or at the stop cock in the stove, so as not to exceed that amount. If the room in which the stove stands is large and well-ventilated, or if small and well-ventilated at the top and bottom, a gas stove can doubtless be used with comparative safety. The ventilation at the top of the room allows the carbonic oxide to escape, while the cold air flue admits fresh oxygen into the room. It is probable that a gas-stove with the supply of gas properly regulated could be used without danger, in a room of medium size, by opening a window in the room a little at the top. The Drs. Greene think that a gas stove should not be used at all in the chambers of the sick, and they urge the importance of carefully regulating the supply of gas and of securing good ventilation wherever gas stoves are used."

These facts are well worth the careful consideration of gas companies and gas-fittera, as very often the neglect of some simple provision may throw trouble and discredit upon the company for which they are really not responsible. The introduction of gas for domestic purposes other than those of illumination, is a most desirable thing for every company, as well as for the consumer; but, to be successful, the first important point is to make it safe. That it is safer than other means of heating, when properly used, there can be no question, but pains should be taken to instruct consumers in the use and regulation of the apparatus. One thing is very certain, and that is that the liberation of a large proportion of carbonic oxide in any room is exceedidgly dangerous to life, and especially so where the ventilation is not much more perfect than in most dwellings.

We would call the attention of our readers to the article, in another column, by Mr. John Wallace, upon the subject of "The Combustion of Gas to Produce Heat."

Illuminating Gas.

[Chemist of Berlin Municipal Gas Works.]

Translated by T. H. Muller.

The essential practical properties of illuminating gas depend on two classes of gases, viz.; the light-producing and the light-carrying, or diluents. These latter form abou 90 per cent. by volume, and are composed of 50 per cent. hydrogen, 30 per cent. marsh gas, and 10 per cent. carbonic oxide. These gases dilute the illuminating gases proper in such a manner that, under favorable circumstances, it is *possible* to burn it *without smoke;* they are, therefore, as important and necessary as the illuminants. The latter are made up of about 4 per cent. olefiant gas, 3 per cent. butylene, traces of acetylene and crotanylene, and vapors of liquid hydrocarbons. If these gases are seperated by cooling to 15°, the gas loses about 35 per cent. of its candle power. These hydrocarbons are not free from phenyl oil, and possess, in consequence, that penetrating smell which happily indicates any escape of unburnt gas. This mixture of illuminants and non-illuminants, as sent out from our works, is of very constant candle-power, owing to the good and even quality of the coals used, and also due to the manner of working which is the same in all the four stations belonging to the corporation.

The candle power is, from the official test, on an average, 16·75 candles, when burning 150 litres per hour, in Argand burner, with a flame 45 millimeters high. The London gas for the same period, by official reports, is shown to be 16·25 candles, making the Berlin gas half a candle better than the London. In Berlin the tests were not made with a nicely-adjusted burner, giving the above results when all the "nice and fine points were observed," but simply a well-made burner —such as may be obtained by the public at large. Without doubt the candle power depends largely upon the selection of the burner, as they may not by any means show the true value of the gas; and it is, therefore, the duty of every member of the profession to expose those badly-constructed burners—not that they do not burn the gas sufficiently, but, on the contrary, all these poor burners burn the gas too much, by conducting so much air to the flame that the maximum of illuminating power is exceeded, and large portions of the illuminants are burned to carbonic acid before reaching the glowing zone.

There are bad burners for small, medium, and large consumption, Generally it is more difficult to produce the same effect in small flames than in larger ones, because the difficulty in keeping the superabundant supply of air from these flames increases inversely as the consumption. It will, therefore, in most cases, be profitable to use burners for a larger, or, at least, a medium consumption.

The best of all burners is the argand; but I experimented lately with one which, although apparently giving a good light, really only gave 62 per cent. of the light shown by one of recognized good quality. It is deceptive to judge of the candle power of a flame by the appearance thereof. For any consumption above 50 litres per hour, it is entirely impossible to form a true judgment—the photometer alone can then determine the candle power. The co-efficient of consumption divided by the candle power is, for a good argand burner, equal 9; for a bad one 14; for burners for average consumption, of good make 12; badly constructed 24; and it increases, for burners of small consumption, to 45.

Each kind of burner requires, for the production of the maximum light, a certain pressure, it is, therefore important not to overtax the capacity of the pipes. Of all the complaints entered at the different stations about poor gas, fully one-half of them showed that, in course of time, a pipe which had been laid to supply 10 burners was used to supply 50 or more. Under such circumstances the gas is brought into discredit without reason. Each consumer will observe small oscillations in the flames, originating from the opening and closing of thousands of burner cocks, although the differences in pressure are watched, and regulated, in some parts of the day every 15 minutes; in large works, with extensive systems of mains (500 kilometers) it is impossible to eliminate these variations entirely. This, however, may be done by each consumer by placing a small gevernor between meter and burner, in such a place as to be out of the reach of those not interested. At the present time these regulators are often applied close up under the burner, and among the many ingenious devices I might mention Giroud's regulator, which consists of a small brass bell moving in glycerine; at the side is a hole to let the gas through, and in the centre of the top is a small metal cone fitting in a conical mouthpiece of the exit-tube, which is thereby more or less closed.

There are a few intellectual conditions to be fulfilled in using gas to the best advantage; but, these being fulfilled, gas gives, to the fullest extent, most eminent advantages over any other illuminating material, and is used for scientific, industrial, and housekeeping purposes, as well as for heating. Its eminent cleanliness, the absence of all waste, and the facility of regulation, have secured already for gas an extensive application. To use it with advantage for heating it is mixed with atmospheric air, as in the Bunsen burner, the illuminating power being destroyed, and with the proper quantity of air only, the well-known blue flame appears, and all heat enters into the products of combustion.

The radiating heat of the illuminants disappears, but raises the heating effect according to the perfection of the apparatus up to 25 per cent. This must necessarily depend on the nature of the burning materials. The highest theoretical heat of combustion is produced by hydrogen, one gram of which burnt in oxygen produces 34,462 units of heat; carbonic oxide, under same conditions, 2,403 units; marsh gas, 13,063 units; olefiant gas, 11,858 units. The heat produced by one gram of hydrogen is, therefore, the highest; that produced by one gram carbonic oxide the lowest. For the practical effect we have, first, to reduce the weight of the gases to their volumes, as we do not ask how many grams of gas are required to produce a desired result, but how many litres or cubic meters. Now the heat of combustion depends on the specific gravity of the gas, and the specific heat of the products of combustion. Both factors vary for different gases, and this is the reason that the heating power for equal volumes increases with the candle power of the mixture. In order to ascertain this ratio, experiments were made to determine the quantity of gas of different candle power required to heat one litre water from 10° to 100°.

[To be continued.]

The Ashtabula Bridge.

[The following from *Engineering News* seems to give the most definite idea that we have yet seen in print as to the probable cause of this disaster.—Ed.]

With the progress of the coroner's inquest at Ashtabula, some points which bear upon the cause of the disaster come to light. Judging from the reports of the testimony there seems to be no strong evidence that the train was thrown from the track previous to the giving way of the bridge; indeed the impressions of a few of the passengers at the first shock that the wheels were off the rails is naturally the idea that would flash through the brain at such a crisis.

It was previously stated that this bridge was a

Howe truss, built in iron, and carrying two tracks on the upper chord; it had a span of about 156 feet, was twenty feet deep between the centres, and had twelve panels. It was built about eleven or twelve years ago, to replace a wooden structure of some 300 feet in length, the remaining space, at each end of the truss, being occupied by a stone arch, and an embankment. It contained improvements made and patented by Mr. Amasa Stone, then president of the road, was said to be designed by Mr. Joseph Tomlinson, and was constructed in the Company's shops at Cleveland. The responsibility lies, therefore, with the railroad company entirely, if the structure was weak and is shared by no outside firm of bridge-builders.

The officials now connected with the road do not testify that they have ever had any suspicion in regard to the strength of this bridge, and they appear to have no theory to offer for the occurrence of the accident. Mr. Geo. M. Reid, the superintendent of the bridges for the entire length of the Lake Shore Railroad, testifies that he has been in the employ of the road three years; that previous to that time, he was employed by the McNairy & Claflin Manbfacturing company of Cleveland; that he is perfectly familiar with the construction of iron and wooden bridges; that he considered himself perfectly familiar with the Ashtabula bridge, thought it a very strong bridge heavy in all its parts; had never received any report that there was anything serious the matter with it, and it never received anything but trifling repairs. He went through the bridge last September for inspection, examined it for two hours, and while so doing, two trains passed over. He says that he has made bridges a study for twenty five years; that this one was put up in 1865, was considered above the ordinary run of bridges; that he doesn't know there was any objectionable feature, and that he had every confidence in the bridge. Mr. A. S. Rogers, in charge of all the carpenter work between Cleveland and Erie, corroborated Mr. Reid's testimony, and considered the bridge perfectly safe.

So much for the company's employees. The testimony of Mr. Joseph Tomlinson has somewhat of a different complexion. He testifies that he is now general superintendent of light-houses in the employment of the Canadian Government, and resides at Ottawa, Canada; that he was engaged in bridge building from 1840 to 1870, and made the drawings for this bridge. He did this under instructions from Mr. Stone. He never approved of a wrought iron Howe truss over a large span, as it makes an unnecessarily heavy bridge, and all the strains accumulate on the end braces Notwithstanding its weight, it would have been a strong and durable bridge had the main braces been sufficiently strong. They were not made as large as originally designed, and it was his intention that they should be strengthened, but his connection with the company was severed on account of a difference between himself and Mr. Stone concerning this bridge. He thought that the main braces were the only defective parts of the bridge. This was the only defect that he was aware of, except its unnecessary weight. He thinks it would have been an exceedingly strong structure had it not been for these defects. Mr. Collins (the present engineer) had nothing to do in any way with the bridge to his knowledge. The bridge was calculated to carry a moving load of two to three tons to the lineal foot. He was dictated to, in making the plans for the bridge, by Mr. Stone. If the iron had all been good, and wrought according to their patterns, and placed in their proper positions, he thinks the bridge would have been perfectly safe. In the original plan made by Mr. Tomlinson the braces were calculated to bear a pressure of four tons to the square inch. He was informed what alterations had been made in remodeling the bridge. He thinks that a pressure of four tons to the square inch on these braces would have caused lateral deflection. He proposed a method of strengthening the defective braces to Mr. Stone, to which Mr. S. would not listen, and even became angry. It was in consequence of this difficulty that he resigned his situation. Mr. Tomlinson never had any anxiety about the braces. He doesn't think a better set of rods or chords were ever put into a bridge.

We have, further, seen a published a letter from Wm. T. Daly, traveling agent of the Toledo Smith Bridge Company, to his employers. After giving the span and height of the truss, he states the following facts as the results of his own examination. "The top chord is made of five 6-inch I beams, varying from light 6-inch to extra heavy, with a web $\frac{7}{8}$ inch thick. The braces are made of three pairs of 6-inch beams at ends, and three single ones at the centers; counter of two 6-inch beams. There are no beams over six inches in the bridge. The rods are eight, at each panel, varying from $1\frac{1}{2}$ inch to 2 1-8 inch rods. I saw five breaks in the top chords and braces, and about 26 breaks in the rods, and from the look of all the fractures there is no doubt with me as to what caused the bridge to give out. There are not any of the rods or top chord pieces or braces which have any fibre at all. It is almost as brittle as cast iron, The lower chords at the ends are five in number, $1\frac{3}{8}$ by 5 inches, laid horizontally, and, as there was no break in them, I could not judge of the quality."

As the bottom chord is entire, the fault must have been in some other portion of the bridge. The impressions of the last person cited above, as to the quality of the iron, there should be no difficulty in verifying. It looks as if a poor article was employed, and the depth of six inches is a small one for main braces some 23 feet long, even if supported by a counter at the middle of the length. The top chord, too, apparently has no more depth. The design of the bridge should be thoroughly overhauled, and the quality of the material used should be tested. We hear that the railroad company are inclined to deny all claims for damages, for loss of life or injury, on the ground that the accident was caused by circumstances beyond their control, the storm and cold weather rendering the iron weak. Such a defence will necessitate a careful examination of the wreck by competent persons, even if such an inspectien was not resolved on before. Suppose that parties should erect a structure of "cold-short" iron, and, when it fell some cold day, should claim that it was no fault of theirs. If the iron was poor the company cannot waive the responsibility for a bridge built in their own shops, by their own men. If the design was faulty, they are equally bound by the acts of their agents.

Metropolis Gas Supply.

Abstract of the Report of Professor Williamson, Chief Gas Examiner to the Metropolitan Board of Works, on the Results of the Daily Testings of the Gas supplied by the Gaslight and Coke Company and the South Metropolitan Gas Company, during the Quarter ending Dec. 31, 1876.

In the report for the quarter, ending Sept. 30, 1876, it was stated that appeals had been made by the Gaslight and Coke Company in relation to the excess of sulphur found in the gas made at Fulham during the months of August and September last, but that sufficient evidence had not been received to decide the case. It has since been shown that the excess of sulphur was due, on most of the occasions in question, to the fact of the purifying appliances at the Fulham works being inadequate, and that the difficulty of purifying the gas had been increased by the excessive heat of the weather. It was stated by the company's engineer that new purifiers were in course of construction.

Illuminating Power for the Past Quarter, in Standard Sperm Candles.

Description of Gas and Testing Place	Max.	Min.	Aver.
The Gaslight and Coke Company—			
Common Gas, Beckton..... ..	18·6	15·5	17·2
" " Ladbroke Grove....	18·4	15·5	16·9
Cannel Gas, Milbank Street.....	23·2	20·0	21·0
Common Gas, Devon's Road.....	18·3	16·1	17·0
" " Carlyle Square.....	19·8	16·3	17·9
" " Camden Street.....	17·6	15·9	16·7
" " Graham Road.....	19·9	16·0	17·9
South Metropolitan Gas Company—			
Common gas, Hill Street..... ..	18·0	16·0	17·1

At most of the testing-stations the illuminating power has been invariably above that required by the Acts of Parliament.

An appeal was made by the Gaslight and Coke Company with reference to the return of 15·5 candle power in the gas tested at Beckton on the 14th of November last. It was stated by the company's engineer that the result obtained by their own gas examiner on that occasion was 15·95 candle-power. Evidence was produced which led to the decision being given in favor of the official examiner.

Sulphuretted hydrogen has been present in the gas made at Beckton on the 24th, 25th, and 27th of November last, and in the gas made at Fulham on the 14th of December; but has been uniformly absent in the gas made at the other works. The Gaslight and Coke Company made an appeal with regard to the presence of sulphuretted hydrogen returned in the Beckton gas on the 27th of November, with the view of showing that the impurity in question had only been present in a very infinitesimal trace; but the official gas examiner produced a piece of test-paper which showed a very distinct indication that sulphuretted hydrogen had been present in the gas on that occasion. The Gaslight and Coke Company have shown that the presence of sulphuretted hydrogen in the gas made at Fulham on the 14th of December was due to the accidental leakage of a valve in a purifier.

Proportions of Sulphur, in other Forms than Sulphuretted Hydrogen, in Grains per 100 *Cubic Feet of Gas.*

Description of Gas and Testing Place.	Max.	Min.	Aver.
The Gaslight and Coke Company—			
Common gas Beckton.....	19·6	5·9	12·6
" " Ladbroke Grove....	16·7	11·6	14·1
Cannel gas, Milbank Street.....	24·6	14·0	19·0
Common gas, Devon's Road.....	21·6	6·2	12·7
" " Carlyle Square.....	23·6	9·7	14·1
" " Camden Street....	25·3	10·1	14·7
" " Graham Road.....	16·1	10·0	13·9
South Metropolitan Gas Company—			
Common Gas, Hill Street.....	24·3	12·3	17·7

At all the testing-stations the average of sulphur present in the gas has been considerably below the amount permitted by the Acts of Parliament. Only on one or two occasions at Devon's Road and Camden Street has the quantity present slightly exceeded that amount.

Ammonia has been present at all the stations in greater or less quantity during the past quarter. At Devon's Road, Millbank Street, Ladbroke Grove, and Carlyle Square, it has occured only occasionally, and in small quantity. At Beckton and Camden Street it has been almost constantly present, but only in small quantity. At Graham Road the ammonia present in the gas has steadily diminished in quantitiy during the months of October and November, and it has been almost uni-

formly absent throughout December. At Hill Street the quantity of ammonia has been considerably greater than at any other of the testing-stations, and on one occasion it exceeded the maximum allowed by the Act of Parliament.

University College, London, Jan. 8, 1877.

[Communicated.]

CITIZENS GAS-LIGHT COMPANY OF BROOKLYN.

It will doubtless surprise our readers to learn by this issue of THE JOURNAL, of the resignation of Mr. Wm. P. Libby from the Presidency of the Citizens Gas-Light Company of Brooklyn, to take effect on the first inst.; and of his complete retirement from all participation in its affairs. Mr. Libby has been connected with the Citizens company from its inception in 1859, being in fact its first President. Under his skillful control the company was carried successfully through the perils that beset its advent as an opposition element in Brooklyn gas matters, and placed upon a firm business basis. From the outset the company was made a paying institution, and its name became a synonyn of success.

The vigorous administration of Mr. Libby was strongly marked by his active and progressive spirit, and a desire to keep the gas interest abreast of the tide of mechanical and chemical discoveries that have enriched the engineering of the last decade, and there by to improve and cheapen the methods of manufacturing to the benefit of all. He keenly felt the apparent inactivity of the profession and its conservative preference for old routine and well established fact, and was always ready to examine into and give the benefit of trial to any project that commended itself to his judgment as a means of advancing the knowledge of methods of the profession. His views upon these matters, and in that much neglected field, the relationship between the consumer and producer of gas, were not those generally accepted and applied; but subsequent events seem now to demonstrate that his ideas of cheap gas and a more prompt recognition of the consumer as a factor in the gas problem, were not so much in advance of the day of their need.

We shall pay no compliment to Mr. Libby's social characteristics, all who came in contact with him, either socially or in business conference, had but one opinion of them; and the effect of his unstudied courtesy and fair dealing is sharply and distinctly prominent in the lack of all *personal allusion* that has marked the bitter gas controversy in his city during the past year.

We can assure our readers that none more greatly regretted this decision of Mr. Libby to retire from its management than the directors of the company themselves, to whom his action was a cause of surprise and sincere regret, and suitable expressions of the esteem and confidence of his fellow directors marked the close of his connection with them.

We learn that Mr. Jas. H. Stebbins, one of the originators of the company and its largest share holder, for the present, at least, will accept the presidency. His great interest in and long familiarity with the affairs of the company, together with his great business capacity, give the strongest proof that the interests committed to his charge will not suffer.

Mr. Libby has decided to retire from participation in *all* business; but we do not anticipate that his active mind and habit will long allow such a state of quietude to exist, indeed we trust to be able to welcome him back to the gas interest when his rest shall have proved irksome.

***

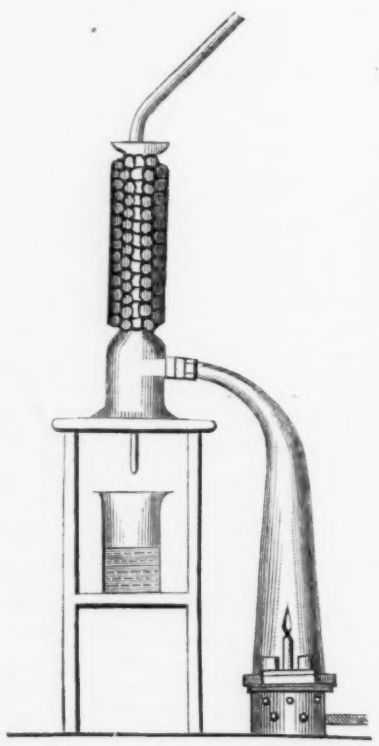
GLYCERINE AS A LUBRICANT.—Chemically pure glycerine, free from water, is recommended as a lubricant for small machines and machinery parts, where common oils and fats turn acid or hard, and so clog or smear. Glycerine is of particular suitability for sewing machines, as any accident with it is of less consequence than with oils which soon become dirty. —*Iron.*

On the Production of Sulphuric Acid by the Combustion of Coal Gas, Etc.

BY W. C. YOUNG, F.C.S.

It is the belief of many eminent gas engineers that the sulphur compounds in coal gas are converted into sulphurous acid by combustion in burners used for lighting purposes, and they are confirmed in their belief by the published opinions of several eminent chemists. The experiments which are the subject of this paper, were made with the purpose of determining the amount of sulphurous and sulphuric acid respectively, that is produced by burning coal gas in different burners, and were commenced nearly two years ago, their progress having been interrupted until lately.

The apparatus in use at the Official Testing Offices for the estimation of sulphur in gas is that known as the Gas Referees' apparatus (see Fig.) and is of the following description.



The gas is burnt in a small Bunsen burner with steatite top, which is mounted on a short cylindrical stand, perforated with holes for the admission of air, and having on its upper surface a deep circular channel, to receive the wide end of a glass trumpet-tube, on the top of the stand; between the narrow stem of the burner and the surrounding glass trumpet-tube, are placed pieces of commercial sesqui-carbonate of ammonia, weighing in all about two ounces. The products, both of the combustion of the gas and of the gradual volatillization of the ammonia salt, go upwards through the trumpet-tube into a vertical glass cylinder packed with glass balls to break up the current, and promote condensation. From the top of the cylinder there proceeds a long glass tube to increase the draught and form an exit for the uncondensable gases. In the bottom of the cylinder is fixed a small glass tube, through which the liquid formed drops into a beaker placed beneath.

The condensed liquor contains the sulphur as sulphate of ammonia.

It is supposed by some that the complete oxidation of the sulphur is effected by nitric acid, formed by the oxidation of the ammonia vapors passing over the flame. The following experiments prove that this is not so, and that the Bunsen flame is sufficient alone to complete the oxidation.

The gas was burnt in a Gas Referees' apparatus having no carbonate of ammonia round the burner. On the top of the glass balls a few crystals of pure carbonate of soda were placed, so that the interior of the cylinder was kept alkaline, and the absorption of the acid vapors assured. Care was taken that no ammoniacal vapor was present. Result:

	Apparatus with $(NH_4)_2CO_3$ round burner. Grains S in 100 cu. ft.	Apparatus with Na_2Co_3 on top of cylinder. Grains S in 100 cu. ft.
1	9.27	9.65
2	10.30	10.60
3	9.40	9.75
4	11.20	11.60

Having found that the modified apparatus gave as perfect results as the original, the Bunsen was replaced by a common fish-tail and other burners successively, and the gas burnt at the rate of about 1 cubic feet per hour (that being as much as the dr through the apparatus would permit). The condens liquor was then made up to a known bulk, a porti boiled with hydrochloric acid, so as to expel any s phurous acid that might be present, and the S es mated as $BaSO_4$. Another portion was acidified w nitric acid and set aside for twenty-four hours, a the S estimated as before; the difference between t two estimations being ascribed to sulphurous ac The results are stated in grains of sulphur per cubic feet of gas.

	As H_2SO_4.	As SO_2	S by Ref. a
Fish-Tail Burner.			
1	11.1	.2	10.9
2	12.1	.3	11.7
3	9.3	.0	9.1
London Argand Burner.			
1	12.7	.4	12.6
2	11.3	.2	11.1
3	11.4	.4	11.3
Common Iron Argand.			
1	8.5	.0	8.5
2	9.1	.2	9.0
3	10.3	.4	10.1

In these experiments the conditions were favora to the production of sulphurous acid, as the supply air to the burner was little more than sufficient produce a steady flame, and of course would be than when in ordinary use. As will be seen, h ever, the oxidation was as complete as in the Bun burner, and but a mere trace of sulphurous acid obtained in either case.

There can be no doubt, that the notion that phurous acid was the principal product of the c bustion of sulphur compounds in coal gas, arose f the statements to be found in most text-books, t when sulphur or sulphuretted hydrogen is burnt an excess of oxygen, the product is sulphurous a When sulphur is burnt in *dry* oxygen, sulphur acid alone is produced of course, but in *moist* oxy sulphuric acid will be found in addition. The s ment is insufficient as regards sulphuretted hydro as sulphuric acid may always be found in the pro of its combustion.

In order to see how far the simultaneous pro tion of water during the combustion of sulphur c pounds affected the oxidation of the sulphur pres I burnt sulphuretted hydrogen, a mixture of hy gen and sulphuretted hydrogen, and coal gas cha with bisulphide of carbon, respectively, under a t pet-tube fixed to a vertical cylinder, two feet and four inches in diameter—about twice as larg the condenser in the Referees' sulphur apparat differing in shape from the latter, in having two n at the top. In one of these necks was fitted a s ating funnel, through which a strong solution of caustic soda was slowly run on to the glass balls which the interior of the cylinder was filled; t other was fixed an eduction tube. In the botto the cylinder was fitted a tube through which the li ran into a vessel beneath. In this way a large line surface was obtained, which was being const renewed from the stoppered funnel.

One portion of the liquor obtained was boiled HCl, another diluted very considerably with w acidified with HNO_3, and set aside for 24 hours S estimated in both as $BaSO_4$.

The H_2S was burnt at as low a rate as possible the result showed that very nearly one per cent o S was converted into H_2SO_4.

A mixture of H and H_2S containing 4 per cent. of the latter, produced no sulphurous acid during its combustion.

The coal gas was charged with bisulphide of carbon, by passing it over a solution of the latter in olive oil. In the first experiment the gas was burnt at the rate of .5 cubic feet per hour, the result showing a total of sulphur amounting to 444 grains per 100 cubic feet, of which 422 grains (95 per cent.) had been converted into H_2SO_4.

In a second experiment the solution of bisulphide used was very much stronger, and the gas was burnt at the rate of .2 cubic feet per hour. The result was as follows: Total sulphur, 1644 grains per 100 cubic feet, of which 1260 (or 76.7 per cent. was converted into H_2SO_4.

It is evident from these experiments that the presence of aqueous vapor, or its simultaneous production, does very materially effect the oxidation of sulphur, and that, practically, the sole product of the oxidation of the sulphur in coal gas is sulphuric acid, even if that impurity be present in very large quantities.—*The Analyst, from American Chemist.*

The Manufacture of Coal Illuminating Gas.*

By Alfred P. Trautwein, M. E.

Continued from page 26.

Coke, probably, was the first material for filling scrubbers and until quite recently it was very generally preferred to all others. This was undoubtedly owing to its apparently great porosity; recent experiment, however, has made evident the fact that these pores do not, as a rule, completely penetrate the coke and that, since these soon become clogged up with tar, no particular merit can be claimed for coke as a scrubbing agent. One of the objections which are being urged against coke is the fact that, because of its irregular form, it occupies too much of the space in the scrubber while at the same time, it does not present as large a surface as would at first sight be expected. When coke is used for filling scrubbers the larger pieces, of about the size of the fist, form the lowest layer which is made two or three feet in thickness; a similar layer, composed of somewhat smaller pieces, comes next and so on, the pieces being reduced in size until, finally, those of the uppermost layer are no larger than a walnut. This plan is evidently much to be preferred to that of throwing in the coke indiscriminately.

Brushwood also seems to be in great favor as a scrubbing agent, and it possesses this advantage over coke, viz., that it is not so liable to become clogged with tar. It is very frequently used in conjunction with coke; the lower layer two feet in thickness, it is then made up of very large pieces of coke which here serves the purpose of subdividing the stream of gas rather than of a scrubbing agent; the remainder of the scrubber is filled in with brushwood, carefully selected and laid, each layer of, say, a few feet in thickness, being supported by means of wooden trays. This, as already stated, is a very common arrangement and is, no doubt, the best form of scrubber. Its contents, however, should be renewed two or three times a year, and it will then give but a very slight back pressure; if, in the mean time, the back pressure become unusually great from temporary accumulation of tar and naphthaline, the plan is resorted to of "bye-passing" the gas and introducing a jet of steam into the scrubber; this will generally have the effect of dissolving the crystals of naphthaline, and of causing the tar to be readily removed.

We have not yet touched upon the fifth of the above conditions. By strong liquor is there meant the wash-water which has absorbed a sufficient quantity of ammoniacal compounds, particularly the carbonate and sulphide, to make it acceptable to the chemical works, where it is used in the manufacture of sulphate of ammonia. Its strength is generally given in degrees of Twaddel's hydrometer, which is graduated in such a manner that each degree corresponds to about two ounces of sulphuric acid per gallon of the liquor.

In order that the ammoniacal liquor, as the wash-water is called, shall be of the requisite strength and shall perform its duty in a thorough manner, it is not only essential that it be used over and over again, but its supply and distribution must be so arranged that it shall be as nearly uniform as possible, and preferably in a state of minute subdivision. This is accomplished in a great variety of ways, some of which we will now examine.

For a long time the wash-water was introduced into the scrubber in the form of a large number of fine streams issuing from one or more "rose-jets," while in many cases a simple, coarse netting on the upper layer served the purpose of distributing it. In other instances this was effected by means of a device resembling a Barker's mill; this, however, required too much water for its operation, and the spray-pipes were finally revolved by power.

Thus distributed, the water descends the scrubber uniformly and slowly, taking up with avidity the greater part of the ammoniacal impurities and several of the sulphur compounds. The gas generally enters the scrubber at the bottom and it is obvious that, in order to obtain the best results, the gas should flow in a direction opposite to the current of water, thus meeting the strongest liquor upon first entering. In very many cases the scrubber is arranged in such a manner that the gas passes up one-half of it and down the other—in other words, meeting the liquor on one side and descending with it on the other, thus completely counteracting the good effects of the first half. It is, therefore, generally considered advisable to use at least two scrubbers; employing the ammonia liquor as the wash-water for the first and fresh water in the second, and mainly for the purpose of removing any slight traces of ammonia which might still remain in the gas.

Books of reference on the subject are exceedingly meagre in regard to rules which might be observed in proportioning a scrubber, and even these are quite as arbitrary and indefinite as are those relating to condensation. Clegg, for instance, simply states that one cubic foot of wet scrubbing material must be provided per 1000 cubic feet of gas per diem. This rule appears generally to have been pretty closely followed; in one particular instance, that of a large works in New York city, the scrubbers were designed to present about eight-tenths of a cubic foot of material—coke and brushwood—per 1000 cubic feet of gas passed per 24 hours.

The height of a scrubber is generally made two or three times as great as its diameter, or its width and depth; its cover should be capable of being readily raised, and a number of manholes should be provided at intervals of four or five feet. Each scrubber should have its own bye-pass and a pressure gauge by means of which any undue accumulation of tar and naphthaline is immediately observed. The liquor should be drawn from the tar-well by means of a steam pump and delivered into a tank elevated at some height above the scrubbers, and located generally on the roof of the condenser and scrubber house.

The use of scrubbers, such as have thus far been described, is very strongly condemned by many gas managers, the so-called

WASHER

being a very common substitute. It should be remarked, however, that the washer to which reference is here made is not of the kind already spoken of above, nor as modified by Cathels and others. In these forms of washer the gas is cleansed by being forced through a sheet, of the wash-water, or preferably through a large number of light hydraulic seals. In the class of washers which we now have to deal with, and which is more generally preferred, the water is brought into contact with the gas in the form of a fine spray.

As ordinarily arranged the spray-washer, as this piece of apparatus is called, consists of two or more iron chambers arranged in such a manner that they are in communication with one another.

The gas upon entering the washer at the bottom of one of the chambers meets the spray of wash-water, which generally enters the apparatus at a number of points, by means of perforated pipes projecting into the chambers. In cities the ordinary water pressure is sufficient to secure a proper distribution: in many cases the water supply is drawn from an Artesian well, and it is customary to produce the required spray by allowing a jet of water to impinge under pressure upon a small button.

But although nothing can be said against the thoroughly efficient manner in which the spray-washer accomplishes its object, it is open to the very serious objection that in order to do this, a great quantity of water must be provided, which certainly is very objectionable in more than one respect; the water, however finely it be subdivided, still descends the washer too rapidly, and does not remain in contact with the gas a sufficient length of time to enable it to absorb the impurities to its fullest extent. For this reason the spray-washer has been modified in a large variety of ways: thus, for instance, a number of horizontal perforated trays were placed in the chambers about two or three feet apart, while in one of its modifications a large number of wooden shelves were provided, arranged in such a manner that at their edges the wash-water forms a series of thin sheets through which the gas is compelled to pass; this form of shelf-washer as it is called is, sometimes modified by inclining the shelves or plates at an angle of about 30°.

But although the several scrubbers which we have described are quite efficient, it must be admitted that they are far from being perfect in every respect: they evidently do not present as large a surface as might be desirable.

On the other hand it may safely be asserted that all of the five essential conditions which were pointed out above are fully complied with by the

LIVESEY SCRUBBER OR WASHER,

as it is variously known. In this the scrubbing material consists of a large number of rough pine boards about one-quarter inch in thickness; they are nailed to a series of small upright pieces about nine inches in length, in such a manner that they are about half-inch apart. A wooden grating, about nine inches in depth is thus formed, which, compared with its bulk, certainly presents a remarkably great amount of wetted surface. The scrubber is provided with a series of these horizontal tiers, a distance of about two and a half feet being left between them. It is believed that this is the most efficient piece of apparatus which has thus far been designed for its purposes, and it will without doubt, and at no very distant date, supercede every other of the present forms of scrubber and washer.

The Livesey scrubber has for some time been in extensive use in Great Britain, and it is now being largely introduced in this country; in this immediate vicinity alone not less than four works at the present time are being provided with scrubbers of this kind, though the details have been variously modified, viz., the Newark, N. J., the two starions of the Manhattan and, finally, the New York Gas Works. In the case of the first three of these works an improved system of supplying the wash-water to the scrubber was introduced; they are particularly remarkable for their unusually great height (about 60 feet), while in the case of the Manhattan scrubber the novel arrangement was resorted to of placing the water and the distributors, under cover on the tops of the scrubbers; the scrubbers themselves, it may be remarked, are cylindrical, are constructed of heavy cast iron are surrounded by a boiler iron shell; they are not enclosed in a building and in the winter it is proposed to keep them at a proper temperature by means of steam pipes in the space between the two shells. In the case of the scrubbers at the New Yerk Gas Works a further modification was introduced in attaching a number of inclined wooden slats to a vertical shaft

* A Graduating Thesis at the Stevens Institute of Technology.

which is slowly rotated by means of mechanism. The slats occupy the space between the several stationary tiers of boards, and a more thorough contact between the gas and the wash-water is thus secured. Before concluding our remarks upon the Livesey scrubber we might add, that in all of the instances above noted, where it is now or presently will be in use, a consumption of one gallon of water for every 1000 cubic feet of gas passing the apparatus was calculated upon, which it might be well to state, is considerably less than what experience has indicated to be required in other forms of scrubbers and washers.

The gas is now in a state of comparative purity, but in order to make it a saleable product it must be subjected to a further process of purification, which has for its object the removal of those constituents which are objectionable from the circumstance that they tend not only to largely reduce the illuminating power of the gas, but also to render it obnoxious in a sanitary point of view. It constitutes, as previously stated, the third and final of the several operations of gas manufacture, and is technically known as

PURIFICATION.

It is true, the several operations of condensing, washing, and scrubbing the gas might have been comprised under the general head of purification; on the other hand, it was thought advisable to make the above distinction because of the fact that the process of purification which we are about to consider is accomplished by chemical means, thus differing essentially from the others. It consequently involves chemical principles chiefly, a lengthy discussion of which, though very interesting, our limited space does not permit. We will therefore confine ourselves to the following *resume* of the impurities, whose presence, as already hinted, is so deleterious that they must be eliminated either entirely, or at least to within a certain small percentage. It thus contains, in the first place, a considerable quantity of carbonic acid, which, being largely in a free state, is highly injurious to the illuminating power of the gas; it is also present in the form of carbonate of ammonium, though in smaller quantities.

The sulphur compounds constitute a very large percentage of the impurities in the gas; they are, undoubtedly, the most troublesome of all, and a great diversity of opinion has always existed as to the form in which the sulphur is present at this stage in the process. It is certain, however, that it enters mainly as sulphuretted hydrogen and as sulphide of ammonium, while it also exists in the form of bisulphide of carbon and as sulphocyanide of ammonium. It might be well to add in this connection, that quite an appreciable amount of sulphuretted hydrogen is removed during the processes of washing and scrubbing the gas by means of liquor, whose free ammonia has a great affinity for this sulphur compound.

In addition to the above impurities, the gas contains small quantities of carbonic oxide, nitrogen, various cyanides and free ammonia.

In Great Britain generally, and in many instances on the Continent, the amount of sulphur and ammonia, permissible in the gas, is strictly confined to certain limits, and heavy fines are imposed for any shortcoming in this respect. These restrictions are particularly stringent in London and vicinity; by the Metropolis Gas Act of 1860 the purified gas is not allowed to contain more than 20 grains of sulphur in 100 cubic feet of gas. The experience of the works supplying London has shown that it is impossible to continually come within the limits prescribed by Parliament, and the result has been a constant series of litigations between the gas companies and the Board of Gas Referees which is appointed by the Board of Trade, for the purpose of examining into the quality of the gas both as regards its purity and its illuminating power. Gas legislation of a similar character, though not nearly as exacting, exists in the Dominion of Canada and in a few American cities, among others in Baltimore, Md.

It is not at all surprising, then, that the subject of purification has received a vast amount of attention, particularly in England; a further impetus was given to this matter by the fact that in many instances the local authorities, too, for sanitary reasons, placed restrictions upon the gas manager on account of the emanations from the purifier-house and the spent material. We thus have a large number of processes at our disposal, all more or less efficient, and from which we will make our selection.

[To be continued.]

The Combustion of Coal Gas to Produce Heat, and the Theory of the Structure of Flame.

By JOHN WALLACE.

[From "Journal Society of Arts."]

Wherever heat is required it is wanted in a certain definable quantity. This quantity is constant for any given purpose; that is to say, whether the object is heating a building, heating or melting metals, cooking, or any of the numberless operations to which we apply it, the same operation, however often repeated, under the same conditions, requires the same amount of heat.

The quantity of heat produced in order to perform any operation is always in excess of that actually required, because the whole of it cannot be utilized. Radiation, convection, and absorption are all at work to carry off as much as possible, and the amount thus lost depends in a great measure on the method we adopt in applying it. This is well exemplified in the weight of coal required to evaporate 10 lbs. of water in a steam boiler, of good or of bad construction, or in the weight of coal used in different stoves or fireplaces to heat a room of a given size. The value of any material as fuel depends principally on its freedom from incombustible matter, and the facility with which it may be burnt in any desired quantity. Coal gas possesses these properties in a very high degree, and the condition in which it is supplied to consumers renders it the best kind of fuel for every domestic purpose requiring heat.

In many manufactures gas is the only fuel suitable for numerous delicate operations requiring a certain heat under perfect control; indeed, the possession of such a means of producing heat has given rise to numerous thriving industries which could not prosper without it.

Ordinary London gas requires to combine with about 6½ times its own volume of atmospheric air in order to be completely burnt. It will not combine with more, but if it gets less, then part of the gas which could not find enough of oxygen will escape only partially burnt, in a condition very injurious to health.

When completely burnt, a cubic foot of gas will produce a definite quantity of heat, and although some makers and vendors of gas apparatus claim for their goods the property of increasing the effect I have just indicated, it is no more possible to do it than to increase a pint of new milk by adding water.

The chief points to be observed in using coal gas are, consequently—1st, to burn it in the most complete manner; and, 2d, to utilize as much as possible of the heat produced.

There are two methods of burning gas to produce heat, each having its own merits. In one case the gas is divided into a number of small jets, exposing a very large aggregate surface to the action of the atmosphere. In the other case, air is mixed with the gas before burning, so that only a part of the total combining quantity of air has to join the gas at the surface of the flame. This allows the surface to be greatly reduced, and the bulk of the flame to be increased, and consequently renders it possible to burn a greater quantity of gas than before in a given space.

The latter method, which is due to Prof. Bunsen, is the one almost invariably adopted in burning large quantities. The gas can not only be burnt in much less space than formerly, but it gives off no smoke, and consequently deposits no soot on any surface which it may be required to heat.

I light the gas issuing from a tube half an inch in diameter, and you see a long, straggling, smoky flame, As it is only by contact with the atmosphere that combustion can be supported, the gas has to expose a considerable surface to the air in order to get its supply. There is a hollow space in this flame extending to at least two-thirds of its height, and full of gas, which can only burn when it meets the oxygen. The sheath of flame surrounding this hollow space represents that part of the gas already under the influence of the oxygen, and the thickness of the sheath may represent the distance to which the oxygen penetrates before it is completely combined with the gas. If a vessel of water or other cool substance were placed over this flame, a coating of soot would soon be deposited. But the moment I admit air to mix with the gas below the flame, the flame contracts to at least one-sixth of its previous size, the illuminating power disappears, and all the heat the large flame gave out is now produced by the smaller one. This flame deposits no soot, but on the contrary, will burn it off a coated surface.

Returning to the smoky flame, I coat a piece of tin plate with solid carbon, which has suddenly been changed from the invisible and gaseous form into a wonderfully fine black powder; and, now admitting the air, the flame shrinks and intensifies, the carbon is again transformed, and is now carbonic-acid gas.

Bunsen, or atmospheric burners, no matter what their form may be, all possess certain essential parts in common. There is a gas-jet orifice, and, in close proximity, one or more air openings. There is a chamber where the gas and air mix and there is an outlet where the mixture burns.

Here is the simplest known form of Bunsen burner. It consists of a straight upright tube, with a gas-jet orifice at the bottom, and holes at each side of the jet, through which air is drawn by the inductive force of the gas. On removing the tube and lighting the jet the gas burns in a long pencil from the orifice, but, when the tube or mixing chamber is put on, the gas must burn at the top.

If the gas should light inside, then combustion is interfered with, and partially burnt gas begins to escape producing that sickening smell which has brought the Bunsen burner so often into disrepute. The Patent Office bears witness to scores of inventions devised to obviate this defect, and it is my purpose to exhibit to you several forms of apparatus designed to avoid this most inconvenient tendency.

I shall now direct your attention to the appearance of the flame, as it is in all cases an unfailing index of the value of the burner for practical purposes. Not only must the proper proportion of air be mixed with the gas, it must be mixed intimately, otherwise the flame will be irregular, produce a roaring noise, and be liable to light within on a slight change of pressure. The roaring appears to be caused by certain parts of the column of gas and air having explosive proportions which ignite and burn more readily than the rest. These explosions are so rapid as sometimes to produce a musical note. This irregular mixture may be cured in the common burner by lengthening the tube and by other methods.

Here is a burner one inch in diameter, with a flame which shows all the peculiarities of good combustion. The flame has a hollow space within represented by a most brilliant emerald green cone resting on the tube. Above and around this is a clear, amber-colored flame. The cone has a sparkling irregular surface, and the flame shows a strong disposition to "light down," indicating an imperfect mixture of gas and air in the tube. To render the admixture more complete, I shall put into the tube a piece of sheet metal, folded in such a manner as to divide the tube into several flat passages. The flame is now quite steady, although the air openings at the base of the tube are full open, and the gas may be turned up and down within wide limits with perfect safety. In this case the surfaces against which the gas passes give it a rolling or eddying movement, which thoroughly mixes the gas and air before they reach the flame. A mass of loosely-twisted wire will produce nearly the same effect, but it reduces too much the velocity of the current.

Another, and a more complete method employed to adjust the proportion of air is exemplified in the "cam" burner.

At the base of the tube is a gas cock, having an eccentric fixed on the plug or key, which lifts the air-slide in such a manner as to adjust the gas and air at one movement. The curves on the cam or eccentric are so made that on one side the maximum amount of air is admitted, producing an oxidizing flame, while on the other side the curve allows a less amount of

air, producing a deoxodizing flame. By quickly reversing the cock, the air slide is closed, and pure gas burns at the top of the tube. In addition to this, the burner tube is hinged so as to incline to any angle, making, on the whole, a very useful laboratory burner.

To illustrate the intensity of the heat of the flame, I shall expose to it a stout piece of copper wire. It becomes rapidly red hot, then a pale golden color, and now it has fallen in molten drops into the vessel of water placed below the flame. Copper is estimated to melt at 2,245° F.

It is not always convenient to use a burner of this description, because if the pressure were to be suddenly lowered independent of the gas cock and cam, it would light down and cause the usual nuisance.

In order to have a burner which shall be absolutely safe and reliable under all variations of pressure and quality of gas, another form of burner must be used, of a class represented by the tangent burner.

It consists of a circular chamber, into which the jet of gas enters at a tangent, drawing with it the air necessary for pre-admixture. The compound eddies round the chamber escaping finally at the tube a perfect mixture. A diaphragm of wire gauze below the tube prevents the flame from getting into the chamber, and a covering of the same material protects the jet orifice of the gas.

This burner may be made of various sizes, of which I have here an example with 12 flames.

It is now time to inquire how much air is mixed with the gas previous to combustion. The tables I. and II. contain the desired information. They were made upon Newcastle coal gas, combining with about six and a-half volumes of air, and as the same coal is used to make London gas, they will serve to represent the results of burning London gas under the same circumstances. They show how much air may be safely mixed previons to combustion in a burner of a given size.

The burner used for this purpose had a tube seven-sixteenths of an inch inside diameter. The consumption of gas was maintained as nearly uniform as possible. The tables indicate the changes in the appearance of the flames as the pre-admixture of air varied. The result showed that one and a-half volumes of air was the maximum limit of pre-admixture with a seven-sixteenth inch burner; if the air exceeded that amount the flame would go down the tube and burn within. If, on the other hand, less than 65 per cent. of air were mixed previous to combustion, the flame began to burn imperfectly and deposit soot, There must always exist a certain proportion between the diameter of a burner tube, the quantity of gas passing through it, and the quantity of air mixed with the gas. A well-made burner will be equally efficient with gas at all pressures, from three-eighths of an inch up to any number of feet on a water-column: and it is difficult to say how much gas may be burned through one tube. We have already observed that as the pre-admixture of air increased, the flame becomes smaller and more intense. Bearing in mind, then, that the nearer a substance to be heated is placed to the source of heat, the more rapidly the heat passes into it, we find that a vessel of water may be placed nearer the center of the flame without interfering with combustion. There is also less risk of the flame being fouled in its own products when the amount of air it takes up while burning is reduced to a minimum.

Experiments on the Proportion of Gas and Air, Mixed Previous to Combustion, in Wallace's Burner.

Table I.—*Pressure of Gas and Air six-tenths of an Inch.*

Experiments.	Height of inner cone.	Height of outer flame.	Volume of gas per hour.	Volume of air per hour.
	Inches.	Inches.	Cu. feet.	Cu. feet.
No. 1.....	·29	2·75	6·00	8·22
No. 2.....	1·00	2·55	6·00	6·00
No. 3.....	2·40*	3·30	5·82	3·66

Table II.—*Pressure of Gas and Air fifteen-tenths of an Inch.*

Experiments.	Height of inner cone.	Height of outer flame.	Volume of gas per hour.	Volume of air per hour.
	Inches.	Inches.	Cu. feet.	Cu. feet.
No. 4.....	·55	3·30	8·84	12·72
No. 5.....	1·00	3·30	8·88	10·92
No. 6.....	2·40	4·30	9·00	6·96

In Table III. are the results of three trials made with the illuminating burner against the Bunsen burner. A vessel of tin-plate, containing one pint of water, was placed over an illuminating burner of the batswing form at a hight above the flames chosen out of three trials as the best position. The same vesse and quantity of water were placed over the Bunsen burner with like precautions:—

Table III.

Experiments.	First. min. sec.	Second min. sec.	Third. min. sec.	Average. min. sec.
Batswing.....	12·43	12·45	12·48	12·45
Bunsen.....	9·32	9·32	9·33	9·32

The results of this experiment serve to confirm whlut has just been stated. With gas burning in both cases at the rate of four and a-half cubic feet per hour, the water was boiled in 9 minutes 32 seconds by the Bunsen burner, whereas the batswing required 12 minutes 45 seconds. The balance in favor of the former is, therefore, 3 minutes 13 seconds, or 25 per cent. As the diameter of the Bunsen burner is increased, it becomes more and more difficult to obtain a good and steady flame. Increase of length gives the air and gas more time to mix and produce a regular flame, but the slightest disturbance causes it to strike down. The experiment with the folded plate and twisted wire as slight obstructions made a certain improvement, but could not be called a complete remedy. The rose top is the best known appliance, but when made of large size the combustion in the interior of the flame becomes imperfect, and, after all, it will not bear turning low without striking down. Another necessary condition also presents itself, increasing the difficulty of obtaining a good large flame. The proportion of air mixed previous to combustion must be greatly augmented, because the surface of the flame (which takes up the remainder of the air to render combustion complete) does not increase in the same ratio as the volume of the flame. If the flame be long and straggling, although giving off no unburnt products, it will certainly deposit soot when applied to the cold surface of a vessel of water; it therefore becomes a matter of the greatest importance, that the burner be of a form that is free from the risk of striking back when lighted. To meet this difficulty the perforated cap has been devised, which, by reversing the usual principle of construction, gives the most remarkable results. Instead of regulating the admission of air from below by partially closing the air orifices, it is done at the top by back pressure.

A cap of perforated metallic plate is fitted over the top of the burner tube and made to slide up and down, so as to adjust the number of openings through which the air and gas are to escape into the flame. The cap offers more or less impediment to the upward passage of the gas, and thus controls and regulates its power of drawing in air at the bottom. This burner has been found capable of burning every kind of coal gas with equal facility. When lit, and adjusted to the maximum amount of air, the cap is studded with brilliant green beads forming the base of the flame; each bead corresponding with one of these perforations, while above you see a flame which is solid to the centre, and without that hollow inner space which has hitherto been considered a peculiar feature of all round flames.

A piece of fine wire put across the flame close to the cap is incandescent along the whole length enveloped in the flame coming from a burner two inches in diameter and consuming forty feet of gas per hour. When I partially close the air openings, a hollow conical space immediately appears in the flame, and the wire cools to blackness. On again admitting the air the wire becomes immediately incandescent, and the flame is solid as before. In order to make the appearance of the beads more distinct, I shall use a cap with much coarser imperfections, which, if carefully lighted, makes a flame of marvellous beauty. The cap is now studded with an array of gems whose brilliancy would pale that of the brightest emeralds. Their color is entirely on the surface, for they are hollow, and filled with the unburnt mixture of air and gas, and they fade and merge into each other on the slightest interruption of the air-supply at the base of the tube.

These experiments all indicate that a great increase must have taken place in the amount of air mixed previous to combustion. This supposition has already been confirmed by measuaement, proving that a burner two inches in diameter will burn safely a mixture containing 4·6 volumes of air per volume of gas.

Spectrum analysis has not yet thrown much light on the peculiarities of this flame. The carbon lines are exceedingly brilliant in the spectrum of the green beads. but the condition of combustion indicated is not clearly defined. It was at first thought possible that the increased temperature of the flame might cause a combination with the nitrogen of the atmosphere mixed with the gas, but a mixture of pure oxygen and coal gas gave the same spectrum as before, so that the nitrogen may be supposed to pass through it unaffected.

The application of coal gas to cooking seems to have had a fair amount of attention from competent men, and good and useful apparatus are easily obtainable; but it is otherwise with the gas stove, which shows scarcely any improvement for the past twenty years. It has been much ornamented, and that is all. The largest burner put in the smallest case that will hold it without becoming too hot, seems to be the *ne plus ultra* of a gas stove. If a chimney is used, it is put at the hottest part of the stove case, so as to carry off the heat as well as the products of combustion, or still worse, the burner is put in a common fireplace, and at least seven-eighths of the heat go up the chimney. There is no more extravagant method of using gas than this.

[To be continued.]

* Cone almost imperceptible, with short white tail.

Quantitative Analysis of Coal and Peat.

BY SERGIUS KERN, ST. PETERSBURG.

Several analytical processes have been used by me for the estimation of carbon, hydrogen, asb, and sulphur in various coals, and most of them were found to be very accurate, but rather troublesome in execution. The following process was used with great success and may be strongly recommended for laboratories of iron works, &c. By this process the work is easily and quickly executed, giving at the same time very accurate results.

1. *Estimation of Hygroscopic Water.*

3 grms. of the substance in a finely divided state are dried in a porcelain crucible placed in a beaker with a small quantity of sand on the bottom of it. The beaker is covered with a watch-glass, and the whole is placed on a sand bath and heated for about three hours to a temperature of 110°. The end of the operation is easily known by the dryness of the watch-glass. The substance when dried is weighed, and the percentage of loss is next calculated.

2. *Estimation of Carbon and Hydrogen.*

The best process was found to be Liebig's:—The ignition of 1 grm. of coal or peat with lead chromate ($PbCrO_4$) in a tube of hard glass, 0·25 metre long. The resulting carbonic acid, water, and sulphuric acid are passed through a potash apparatus containing caustic potash (1 part of KHO dissolved in 2 parts of H_2O), and two U-tubes, the first containing ignited calcium chloride, the second a solution of lead nitrate. The increase in weight of the potash apparatus and

of the first U-tube will show the quantity of carbonic acid and water obtained. Knowing that carbonic acid contains 27·2 per cent. of carbon, and water 11·1 per cent. of hydrogen, the percentage of carbon and hydrogen may be easily calculated.

3, *Calculation of the Calorific Power.*

As one part of carbon in burning yields 8080 calorific units, and 1 part of hydrogen in burning 34,460 calorific units, the calorific power of the coal may be quickly found.

Example —Coal from Donetz Mountains, near the village Grouchevka, South of Russia:—

	Per cent.
Carbon	58·0
Hydrogen	11·0
Sulphur	1·0
Ash	23·0
Hygroscopic water	6·0
	99·0

For calculating the amount of calorific units in this coal we proceed as following:—

For carbon we have..... $0{\cdot}58 \times 8080 = 4686$
For hydrogen we have.... $0{\cdot}11 \times 34460 = 3790$

Total calorific units in the analyzed specimen.....8476

4. *Estimation of Ash.*

1 grm. of powdered coal is heated in a muffle in an open platinum dish till all the carbon is burnt off. The remainder is the ash which is weighed.

5. *Estimation of Sulphur.*

0·5 grm. of powdered coal is heated with a mixture of 15 c.c. of HCl and 5 c.c. of HNO_3 for about one hour, and next left for 12 to 15 hours on a sand-bath. The liquor is filtered on a strong double filter to prevent the coal-dust passing into the filtrate. The sulpur is precipitated from the filtrate by barium chloride. The solution is left quiet for half and hour and is next filtered; the precipitate of $BaSO_4$ is washed, dried, and then weighed. Supposing 0·5 grm. of coal to be used for the analysis, every 0·001 grm. of barium sulphate obtained is equal to 0·02 per cent. of sulphur.—*Chemical News.*

Specific Gravity of Fixed Oils.

The following table represents the relative weights or specific gravities of different fixed oils:

Sperm	884	Cherry stone	924
Tallow	900	Fish	924
Rape seed	913	Cameline	925
Plum kernel	913	Nightshade	925
Hembane seed	913	Sunflower seed	926
Colza	914	Hemp seed	926
Ground nut	915	Cocoa nut	926
Olive	916	Walnut	926
Sessamum	916	Filbert	926
Almond	917	Anda	927
W. mustard seed	918	Horse-chestnut	927
Radish seed	919	Cod-liver	928
Grape seed	920	Seal	929
Poppy seed	922	Linseed (new)	930
Whale (train)	923	Weld seed	936
B. mustard seed	923	Orange seed	940
Walnut	923	Linseed (old)	960
Cucumber seed	923	Castor	965
Tobacco seed	923		

Most of the fixed oils are affected by the atmosphere—the oxygen of which they slowly absorb. In some cases the oil becomes thick; or, if exposed in a thin layer, it dries. In this manner a skin is frequently formed over the surface of the oil; and if it be left for some time in a lamp, it will assume a jelly-like appearance. Other oils do not become so thick by exposure to the air; but they acquire an unpleasant smell and get rancid. The former is the property of the drying, and the latter of the fat or unctous oils. These changes are due to the action of atmospheric oxygen; indeed, Saussure found that a layer of nut-oil, one-fourth of an inch in thickness, absorbed as much as 145 times its bulk of oxygen in the course of eleven months, of which quantity 142 volumes were taken up during three months' exposure to the sun. It appears, also, that it is the carbon of the oil which undergoes oxidation: and, as it were, slowly burns, evolving carbonic acid. This change is always accompanied with an elevation of temperature; and hence it sometimes happens that rags, tow, or cotton, that have been smeared over with oil, and then thrown aside as useless, have, in the course of a few days, generated heat enough to produce spontaneous combustion. Fires have frequently originated in this manner in warehouses and dockyards, where such materials have been allowed to accumulate. This points to the danger that is attendant on the careless and slovenly trick of throwing greasy rags, and other such matters, into out-of-the-way corners. Those oils which absorb oxygen with great facility, and thereby become thick, are not well-suited for combustion in lamps, unless the lamp is cleaned out every day, and a fresh wick adapted to it. The quick-drying oils are linseed, poppy, walnut, hemp-seed, and nut—all of which are employed by painters on this very account; while rape, colza, sessama, or gingilie, cocoanut, grape-seed, cameline, sunflower, cotton, mustard, &c., only dry after very long exposure to the air; and sperm, olive, almond, seal, and whale oils are not much disposed to dry at all —*Coal Trade Journal.*

Death of Amos. D Smith.

PRESIDENT OF THE PROVIDENCE (R.I.) GAS-LIGHT CO.

At a special meeting of the directors of the Providence Gas Company, holden at their office on Monday, January 22, 1877, the Vice President announced the death of Amos D. Smith, the President of the corporation, at his residence in Providence on Sunday morning, the 21st instant, whereupon it was unanimously ordered by the Board that the following minute be entered upon their records;

The Directors of the Providence Gas Company receive with profound sorrow the intelligence of the decease of their late President Amos D. Smith.

Upon the organization of the Company, in 1848, Mr. Smith was chosen with singular unanimity to preside ovor its deliberations, and to bear the weighty responsibility which belongs to the office of President. For the period of twenty-nine years he held this high office, and until compelled by failing health to relinguish the active supervision of its affairs, he devoted himself with unsparing industry and conspicuous ability to the promotion of the best interests of the Company. He gave to its struggling infancy his time, his energy, and his great personal influence. He lived to see it strong and prosperous, and to receive the reward of his long and distinguished services in the consciousness that its growth and success were so largely due to his unselfish labors and to his steady adherence to the wise and upright rules which were the commanding principles of his life.

We hold in grateful memory these long and eminent services and the delicate consideration for all his associates in the board, which marked his personal and official intercourse with them.

It is hard to feel that we shall no more see his genial face and his stalwart form in the marts of trade. That the voice with whose accents we are so familiar, is hushed forever, and that we shall no more lean upon his solid judgement, and confide in his wise counsels.

His work is accomplished, he has entered into rest, he has exchanged the trials and successes of life, for the awards of immortality. Passing away with the love of those whom he loved so well and with the respect of his fellow citizens among whom he had spent his long and honorable life.

The death of such a man calls forth the utterance of a feeling, almost universal in this community. We unite the expressions of our sorrow with those which come from the church of his mature affections, from hospitals, from the abodes of penury and suffering, made bright by his ready sympathy and generous benefactions, from all those upon whom he bestowed aid and counsel and from that bereaved circle of which he was so lately the center. We approach with respectful sympathy those whom this event has left desolate, and we will ever cherish the memory of our associate and friend.

Voted, that a copy of this minute be sent to the family of Mr. Smith, and that the Directors attend the funeral on Wednesday, the 24th inst.

A. B. SLATER, Secretary.

Correspondence

[Correspondents, in all cases, should sign their communications with their names and address in full—not for publication, unless desired, but as a guarantee of good faith.—ED.

Tar as Fuel.

NEWARK, N. J., January 16, 1877.

Mr. Editor: There is in your Journal of the 16th inst., a criticism by "J," on a paper read before the Society of Gas-Lighting, which states that the method of estimating the heat units for some of the minor constituents of tar, is not correct. This may be so, but I object to a modification of the figures, as given, based solely upon J's ipse dixit.

J writes; "It appears to be a common mistake in estimating the calorific power of petroleum and tar, to make deductions which lessen the heating power when the elements deducted really produce the opposite result, adding to rather than subtracting from the calorific effect of the fuel; and this seems to be the more noticeable in view of the fact that practice on a large as well as experimental scale, demonstrates that the actual heating power of tar and petroleum is larger than the calculated power."

It seems to me that the question is—are there any experimental or practical results on record, absolutely authenticated, that demonstrate that the actual heating power of tar and petroleum is larger than the calculated power?

If so it may then follow that the present method of calculation is incorrect, or may be based on a wrong theory. This question arose at the time of the English experiments referred to, but it seems to have been settled that the actual heating power was not as great as the power calculated by the formulæ.

Prof. Henry Wurtz, in a report on the Eames' System of Furnace Working with Petroleum, appears to sustain the view that the thermal effect of a liquid hydrocarbon may exceed its theoretical power, and offers the following as the explanation:

"Carbon, like everything else, has a *latent heat of fusion* or of liquidity, though the amount of this is yet unknown. It seems probable that it is large in amount. In case of oil fuel we are clearly dealing with liquid or *fused carbon*, which, according to this view, should yield us more effective heat for equal weights than solid carbon in coal."

It seems from the phraseology in J's letter, that he has adopted the Professor's views.

The method adopted by me, in calculating the heats units, was that found in the books, and the figure are correct in accordance with the formulæ, the formula for a fuel containing C, H, and O. being

$$p = C + (H - \tfrac{1}{8} O)$$

the allowance for water, etc., being in accordance with the rules generally accepted.

It is not necessary to take up and refute, in detail, the theories of "J" in reference to the influence of O, water. etc., etc., in the tar, because "J" is evidently familiar with the formulæ, and the facts from which they are deduced.

It is evident that "J" has a theory of his own, not to be found in the books, for estimating the calorific powers of liquid fuels, differing from that generally accepted; indeed he suggests as much in the last sentence of his letter.

De quibus certus es, loquere opportune, Mr. J. instead of attacking the old theory, as embodied in my paper, let us have your own, and the facts upon which it is based; this might prove most acceptable and valuable to every one interested in the use of fuel, entitling you to the thanks of the readers of the Journal, including myself. V.

High or Low Levels for Works.

January 27, 1877.

Mr. Editor: Mr. Cathels states that high levels are better sites for gas works than low levels. He told the Association so, in New York, last October, according to your report of the proceedings.

He adduces as a prime reason, that on the high

levels the distribution of gas can be effected during the day with less pressure on the mains than where the works are on the lower level.

As he did not demonstrate his proposition, and as I, perhaps, did not apprehend his precise meaning, I write to beg the favor of an example applied in illustration.

Two towns, A and B, have each their main lines of distribution on two parrallel streets, one of which streets is situated fifty feet above the level of the other. In all respects the two places are alike, except that at A the works are on the lower street, and at B on the upper.

A checks his pressure to five-tenths in the day time, and has, consequently, one inch on the high street, and half that on the lower.

B runs at one inch pressure, and consequently has a half inch on the lower street, and one inch on the higher.

X seems equal to X, with the exception (no pun intended) that B has the disadvantage of a higher initial pressure.

Now, I don't say this is so; I don't *suppose* that it is so, but it looks so from the tree.

And because it appears thus to my ignorance and I cannot make it right, I have written to ask the favor of an explanation on the basis of the above illustration. E. S. Stultus.

Gas a Positive Blessing.

It is often said "we never appreciate the blessings we have until we have lost them." There is not a little truth in the remark, and we would all take a truer estimate of life if we were permitted once in awhile to realize the value of our surroundings. It would cause an end of much useless fretting and repining, and dissipate a great deal of false and morbid discontent with our lot in life. We were forcibly struck with the literal verity of these things when this city was suddenly left without gas on the night of December 12th. We had been using gas for several years, and had come to look upon it as a matter of course, and sometimes people who are predisposed to grumble, would complain about it, and all that sort of thing, just as they sometimes do about their best and dearest friends, and those things they would be most loath to give up, but they never had fully realized what a positive blessing it was, how cheap and convenient, how utterly superior it was to all other kinds of light, how safe and brilliant and cheerful and how its power of dispelling darkness was more than eighteen times that of ordinary candles at a cost of less than one, these things were suddenly brought before our people with a vivid force they will not soon forget.

We had become so accustomed to gas, we had forgotten how to appreciate the benefits as we do with many other blessings in life. But we undertake to say that there is no difference of opinion on the subject now. The experience of the citizens is too recent, and was too vexatious not to be remembered for years. The miserable makeshifts of dull, glimmering candles, or of evil smelling and dangerous coal-oil lamps, and the snuffing of wicks and trimming of smoky burners, and the constant knowledge that you had at your elbow or above your head an element more dangerously destructive than a six-inch shell, which might at any time explode mutilation and death upon you and upon your loved ones in a moment. caused the beautiful, brilliant and harmless gas to be fully appreciated. What is evident to us all is, that we cannot do without gas; our people, after their late experience, would go to any sacrifice rather than give it up. It is much cheaper than coal-oil or candles. It is very much safer. It gives a vastly superior light. Let us then aid our excellent gas company in extending their enterprise, and to give more of our citizens its benefits. Let us encourage them to put down more pipe in every part of the city, until the whole of Brownsville is illuminated by this beautiful light. As a tallow dip is to the sun, so are all other subterfuges to give light, when compared with this brilliant and beautiful agent. We are surprised that our street lamps have not been lit up since the 1st of December. This should be remedied immediately. Now is the time when light is needed, if it ever is needed on our streets, in these dark and tempestuous winter nights. Let this matter be attended to at once by our new Board. The gas works have been put in complete order and improvements made, which enables the company to furnish a purer and better article of gas than ever. The citizens have been using gas since the 5th of January. Let our street lamps be again lit up. Let us have light.—*Brownsville (Tenn.) Democrat, Jan.* 10, 1877.

For several weeks our citizens were barred by an accident from the use of gas, and in that time they learned the necessity of this mode of lighting up the city. At the first introduction of gas lights in Brownsville they were regarded as a kind of luxury—something very nice but not at all necessary. This idea has been exploded, as it ought to be. No city can be comfortable to its inhabitants or attractive to strangers that is enveloped in darkness every night. Every man who owns property or does business here is directly interested in having the city well lighted up. It serves as a protection against burglars and the general misdeeds of persons who have wicked dispositions. The bright gas light prevents many a heinous crime, and hence it is a potent auxiliary to the moral interests of the community. The gas company is a benefactor to Brownsville and ought by all means to be sustained liberally and generously by all our citizens. The defect in the main pipe has been entirely repaired, at considerable expense, and the light now furnished is the best ever used in Brownsville. It beats the sickly glare of tallow candles so much that we cannot believe our citizens will ever use anything else when gas can be obtained.—*Ibid' Jan.* 11.

Chemical and Scientific Repertory.

Welding Tires.—In welding tires do not, if light steel or iron, "edge up" or hammer on the edges at the weld. Weld solidly on the flat surface; trim the edges with a sharp chisel- and dress with a file. This method saves time and insures success.—*Iron Age.*

Chinese Railroads.—The difficulties that hindered and threatened to defeat the construction of a railway in China, between Shanghai and Woosung, have been adjusted.—*Amer. Manufacturer and Iron World.*

Method of Distinguishing Petroleum Benzine from Coal Tar Benzine.—To a few drops of benzine add a crystal of iodine; the former product is colored raspberry red, while the latter yields a violet red.—*Ibid.*

French Exhibition, 1878.—The governments of Sweden, Norway, Switzerland, and Austria, are stated to have intimated their intention of abandoning participation in the Paris Exhibition of 1878, in case Germany officially refuses to take part in it. Whatever course other nations may pursue, it is quite certain the United States will take a prominent part, and we think there is little doubt but the manufacturers of this country will be more largely represented than at any previous foreign exhibition.—*Amer. Manufacturer and Iron World.*

English Light-House Dues.—A strong effort is making by the leading maritime and commercial associations of the country to induce Congress to re-open correspondence with the government of Great Britain in regard to the light-house duties, as still imposed in that country. The original light-house grants have in now become extinguished, it is considered the right time to ask that the British government maintain the light-houses, rather than compel foreign shipping to be taxed to defray the expenses.—*Ibid.*

Lime Burnt by Petroleum Gas.—Cedar Hollow Lime Company is burning lime successfully with petroleum gas, at their lime works in East Whiteland, Pa. They use Baird & English patent vaporizer to produce the gas, and one small machine produces enough gas to run six kilns, making about 2000 bushels of the whitest and purest quality per day without wood or coal. Their lime commands from 20 to 25 per cent. higher prices in Philadelphia than any other offered for sale in this city, and is mostly used for fine brick work and finishing the best houses there.—*Ibid.*

India Rubber.—Some idea of the extent and value of the india-rubber business of this country may be gleaned from the following facts: The various rubber manufactories employ about 7,200 hands, and the capital invested in the industry may be set down at about nine and a half millions of dollars. The total value of the product is probably not less than $17,500,000 annually. Last year there were about fourteen and a half million pounds of caoutchouc imported into the United States, considerably over one-half of which comes from Para, Brazil, the great depot of caoutchouc exportations from South America. During the same period Great Britain imported about the same quantity, some two-thirds of which was from Brazil, although a strong effort was made to force the Indian caoutchouc on the market.—*Ibid.*

Retort Settings.

Sir: In the report of proceedings of the American Gas-Light Association, in your issue of the 28th ult. I find that Mr. Cathels is under the impression that, in cases in which coal is used as retort fuel, "high chimneys are indispensable to create such a draught as will ensure a sufficient quantity of air being drawn through the furnace to burn each of the bodies into which the coal is resolved, viz., the coke, the hydrogen, and the carbon of the gas into carbonic acid in the furnace instead of at the chimney top, *and for like reason a greater furnace bar area than when coke is used is necessary.*"

As regards the theory set forth in the latter part of the above quotation, I would submit that it is not borne out by facts, as I am now working settings of five retorts, each nine feet long by fifteen inches diameter, in one oven, using coal as fuel, by means of a furnace only two feet eight inches long by five and a half inches wide at bottom, fitted with one two-inch square fire-bar—deducting which we get an air space of only 142 inches.

In this setting a supply of hot air is delivered in thin streams round the top of the furnace, and the combustion being perfect, the heat thus obtained is intense. For further particulars of this class of furnace I would refer your readers to the very able paper read at the meeting of the British Association of Gas Managers, 1875, by Mr. John Tindall, the engineer of the Wallsall Gas Works. The theory of this class of furnace is therein very fully explained, and I have great pleasure in bearing my testimony to its entire success in practice.

In this remote part of the country I have not many opportunities of visiting other works; but question if so small a fire-bar area as the above has ever been successfully worked with coke as fuel.

The perusal of Mr. Cathels' paper has afforded me very considerable interest and profit: but on the particular point in question, the *facts* before me are so much at variance with his *theory*, that I feel constrained to submit them for consideration.

I may add that the chimney at these works is twenty-eight feet high by four feet square inside, and works seven ovens of five retorts each.

M. J. Parsons.

Gas Works, Carnarson, North Wales, Dec. 2, 1876.
—*Jour Gas-Lighting, Dec.* 12, 1876.

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FRIDAY, FEBRUARY 2, 1877.

Acetylene.

Acetylene, ethine, is, perhaps, the most interesting of all the gaseous hydrocarbons existing in coal gas. The proportion found is exceedingly small, which might be wondered at, seeing the numerous reactions by which it is produced, many of which must take place in the retort. It is, for example, formed when marsh gas, the chief constituent of coal gas, is exposed to a red heat. It is also produced when marsh gas and carbonic oxide, another ingredient in coal gas, are heated together. But, unfortunately, acetylene may be said to be born under conditions in which it cannot continue to exist. When exposed alone to a dull red heat it decomposes to form a number of bodies, among which are found olefiant gas, hydride of ethyl (C_2H_6), benzine, and several other liquid hydrocarbons, with the separation of some carbon and hydrogen. Heated with hydrogen, it is also decomposed, with the formation of olefiant gas, benzine and a variety of other compounds. And, lastly, when olefiant gas and acetylene are heated together to dull redness, they are reciprocally decomposed to form a number of products. Thus the gas, which, on account of its high illuminating power, it would be most desirable to retain in coal gas, is produced in the retort under conditions which seem to forbid its continued existence, and the wonder may rather be that any escapes the ordeal.

Acetylene is a colorless gas, possessing a peculiar and rather unpleasant odor. Its specific gravity is 0·868, and 100 cubic inches weighs 28 grains. It is freely absorbed by water, which takes up its own bulk of the gas, and that may be one reason why so little is found in purified coal gas. Being of all the hydrocarbon gases the poorest in hydrogen, it burns, as might be expected, with an intensely luminous flame, but since it can only be obtained in small quantity, no actual determination has yet been made of the light it gives when compared with coal gas.

Acetylene is readily removed from coal gas, in company with the bodies above named, by bromine and sulphuric acid; but we have also an easy means of separating it alone, and of obtaining the pure gas for experiment. If a current of coal gas be gently passed through a strongly ammoniacal solution of cuprous chloride, a red brick colored precipitate is slowly formed, which consists of acetylide of copper. This may be collected and dried; and then, when warmed with dilute hydrochloric acid, pure acetylene is evolved. If the quantity of gas passed through the copper solution be measured, we have the means of arriving approximately at the amount of acetylen in the gas.

Some other modes in which acetylen is formed may be briefly noticed. It is remarkable that it can be produced by the direct union of its elements. When carbon points are ignited by a very powerful battery in an atmosphere of hydrogen, a considerable quantity is formed. With 40 or 50 Bunsen's cells, it is said that as much as 10 cubic centimeters can be obtained in a minute. Acetylen is also produced when coal gas is burned with an insufficient supply of air. Everyone has recognized the unpleasant odor produced, when gas is burned under such circumstances, as, for instance, when the flame of a Bunsen's burner accidentally burns in the interior of the chimney. This is, in part, the result of the production of acetylen. A proof that acetylen is one of the products of the imperfect combustion is easily obtained by inverting a glass flask over the Bunsen's lamp so burning, and afterwards pouring in a solution of cuprous choloride whereupon the sides of the flask become covered with a film of the red acetylide of copper. There are several other modes by which acetylen may be produced, but they have no special interest for gas manufacturers.

Acetylide of copper, it must be mentioned, is an explosive compound, and is occasionally found when coal gas is passed for a considerable time through copper pipes. It is exploded by heat, percussion and friction, and several accidents are recorded, due to its deposition in tubes of copper, employed for the conveyance of gas.—London *Journal of Gas-Lighting*.

An Engineering Feat.

There was accomplished in San Francisco on the 18th inst., an engineering feat which is creditable to the gentlemen under whose direction it was performed. Owing to a change of the Mission street grade it was necessary to lower some twenty-six inches one of the mains of the Spring Valley Water Company. The pipe is twenty-two inches in diameter, and supplies the entire southern and southwestern part of the city. It is made of wrought iron, and weighs nearly sixty pounds to the foot, making the weight of the whole in the vicinity of 60,000 pounds.

On the afternoon of the 17th a force of about 100 men were set to work to uncover the pipe line and dig a trench under it to the required depth. As the work progressed heavy joists were placed across the trench at distances of forty feet, and the pipe suspended by means of heavy screws resting on the joists. At an early hour on the morning of the 18th work was renewed, and about 10 o'clock, everything being in readiness, an order was transmitted to San Andreas, whence the supply is drawn, to shut off water. Simultaneously with this order others of a similar nature were issued to men stationed at the connection of the pipe with that of the Market street line, so as to keep the water from backing into the lower end of the pipe. In twenty minutes the water-gauge showed a reduction in the pressure from over seventy pounds to seven, and ten minutes later the gauge showed tha all the pressure was gone and the pipe free of water. In order, however, to keep up the pressure on distributing pipes, and supply about half the city with water—as otherwise it would suffer a water famine while the work was in progress—water was turned in from the Lake Honda reservoir through the large main that runs down Haight street to Market, and the pressure on this line increased.

Owing to some little delay, occasioned by the watergates not being completely shut, and the slowness of the workmen at either end of the pipe in unfastening the rivets, it was nearly 10·30 o'clock before the pipe was ready to lower. In the meantime a new complication arose, which threatened serious consequences. The sun's warm rays falling on a rigid exposed pipe 1000 feet long, threatened its expansion several inches, which, had it happened, would probably have necessitated the severance of the pipe. However, the preliminary work was rushed through, and twenty-five of the most intelligent workmen were selected to work the screws and lower the main. The circuit of the lever was marked off in quarters—one, two, three, four—and at each signal from a trumpeter stationed at the lower end, and directed by the engineer of the company, Herman Schussler, the workmen simultaneously made a quarter of the circle and then called out the number. This operation was one requiring the utmost caution, as the difference of a turn or two of the screws between any of the workmen would so unequally distribute the strain as to break the pipe. In fifty minutes, but not until the bugler had blown himself sick, and had to be placed on the retired list, the main rested in its bed, the ends were riveted, the water turned into the pipe, and the feat accomplished. Sunday was selected by Mr. Schussler for the work, as on that day there is less water used than on week days. The average daily consumption of water in San Francisco is 14,000,000 gallons, but on Sundays it seldom exceeds 10,000 gallons.—*Iron Age*, xix—2.

Gas Stocks.

Quotations by W. B. Scott & Co., Bankers,

24 PINE STREET, NEW YORK CITY.

FEBRUARY 2, 1877.

☞ All communications will receive particular attention

	Capital.	Par.	Bid.	Asked.
Gas. Co.'s of N. Y. City.				
Harlem	$1,850,000	50	105	110
Manhattan	4,000,000	50	235	238
Metropolitan	2,500,000	100	145	150
" Scrip	$1,000,000	...	100	103
" Bonds	500,000	1000	100	103
Mutual	5,000,000	100	95	97½
" Bonds, gold.	900,000	1000	105	—
New York	4,000,000	100	130	121
Gas Co.'s of Brooklyn.				
Brooklyn	2,000,000	25	175	180
Citizens	1,200,000	20	99	100
" Scrip	320,000	1000	95	97½
Peoples	1,000,000	10	50	55
" Bonds	$ 325,000	...	---	95
" Scrip	300,000	...	85	--
Metropolitan	1,000,000	100	76	80
Nassau	1,000,000	25	80	85
" Ctfs.	700,000	1000	96	98
Williamsburgh	1,000,000	50	135	140
" Scrip		...	98	100
Out of Town Gas Companies.				
Bath, Maine	70,000	100		
Buffalo Mutual, N. Y	750,000	100	—	80
" Bonds	200,000	1000	--	90
Baltimore, Md	2,000,000	100	150	170
" Ctfs., gold	1,000,000		105	—
Bayonne, N. J		100		90
Brockport, N. Y	25,000	100	...	80
Citizens, Newark	918,000	50	97	100
" " Bds.	124,000	—	—	--
Derby of Conn	160,000	100	60	80
East Boston, Mass.		25	132	—
Fort Wayne, Ind		100	...	—
Hannibal, Mo	100,000	100	95	100
Hartford, Conn	700,000	25	152	—
Hempstead, L	25,000	100	...	—
Jersey City	386,000	20	160	—
Jamaica, L. I	25,000	100	...	—
Jacksonville, Ill	120,000	50	82	...
Lewistown, Maine	400,000	100	50	85
Lima, Ohio	60,000	100	--	...
Bonds	30,000		90	
Laclede, St Louis Mo	1,200,000	100	100	110
Peoples, Jersey City		...	125	135
Leoples of Albany	650,000	100	—	20
" Bonds	350,000	1000	--	--
Peoples of Baltimore		25	99	100
" Bonds			106	—
Perth Amboy		25	—	95
Rochester, N. Y		100	50	60
Richmond Co., S. I.	300,000	...	97	100
Woonsocket, R. I	150,000	100	100	...
Halifax N. S	400,000	40	148	150
Hamilton, Ontario	150,000	40	112½	
San Francisco Gas-Co., S. Fr'isco Cal.			99	100
St. Louis, Missouri	600,000	50	—	100
Stillwater, Minn	50,000	50	—	26
Suburban, W'stch'str	390,000	50	—	100

Saugerties, N. Y	15,000	100	110	115
Troy, Citizens.....	600,000	100	—	100
Central, Westchester	466,000	50	90	95

We note sales of 185 shares of Manhattan at 235½ @ 236—at auction.

The Harlem Gas-Light company have declared their semi-annual dividend of 4%, p yable Feb. 5th.

BENCH CASTINGS FOR SALE.

ALL THE IRON WORK BELONGING TO

32 BENCHES OF "FIVES,"

consisting of abont the following, viz.:

225 Feet of Hydraulic Main, 20 in. diameter.

160 Dip, Bridge, and Stand Pipes, 4, 5, and 6 inch.

160 Mouth Pieces, D's, 12" x 20".

Lids, Cotter Bars, etc., etc.

Door Frames and Doors.

The above may be seen at any time, and will be sold either altogether or in lots, at *very* reasonable prices, upon application at the Engineer's Office of the BROOKLYN GAS WORKS, foot of Hudson Avenue, Brooklyn, N. Y. 422—6t

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INSPECTORS OF

Gas Meters and Repairers.

Gas Companies having Meters to be repaired will please inform us. The best references given from different Gas Companies and State Inspectors. Address for terms, office 513 Fourtenth St., Washington, D. C. 411-3m1

FOR SALE---CHEAP.

HAVING BUILT A NEW WORKS, WE HAVE FOR sale, in lots to suit,

4 Sets of Purifying Boxes, each 9 x 16 ft. with Trays, etc., complete. Each set has a ten-inch Dry Center Seal, Valves, and Pipes, all in good order.

Hydraulic Mains, Dip, Bridge, and Stand Pipes, Mouth Pieces, with Doors and Cotter Bars complete for 186 D Retorts, 14" x 22" and 12" x 20". Set in Threes.

4 Vertical Air Condensers. 10 inch Connections.

Four Spray Washers.

Two Sets of the Purifiers and Condensers can be delivered immediately. Apply to PITTSBURGH GAS COMPANY, Pittsburgh, Pa. 422—4t

NATIONAL FOUNDRY

AND PIPE WORKS.

OFFICE AND WORKS—CARROLL, PIKE, SMALLMAN AND WILKINS STREETS,

PITTSBURGH, PA

WM. SMITH,

Manufacturer of all kinds of GAS and WATER PIPE BRANCHES, CONNECTIONS, T's, ELBOWS, and all CASTINGS USED AT GAS AND WATER WORKS,

We offer special inducements to parties wishing to purchase. My Pipe is Smooth, regular in weights, and cast vertically.

N. B.—Pipe from 3 inch and upwards, cast in 12-ft. lengths.

☞ SEND FOR CIRCULAR AND PRICE LIST. ☜

S. DECATUR SMITH,

CAST IRON GAS & WATER PIPE,

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Several Thousand 2, 3, 4, 6 and 8 Inch Cast Iron *Gas and Water Pipes* on hand, for immediate delivery.

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COLUMBUS, OHIO,

MANUFACTURERS OF

CAST IRON GAS & WATER PIPE,

BRANCH CASTINGS, LAMP POSTS, Etc.

(Pipe from three inch and upwards cast *vertically* in 12 feet lengths.)

HEAVY AND LIGHT CASTINGS OF ALL KINDS.

DAILY CAPACITY 125 TONS.

☞ Our Works *connect direct* with *eleven railroads* centering in this city, giving us unequalled facilities for shipping to all points, at the lowest rates of freight. 405-1y

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MANUFACTURERS OF

CAST IRON PIPES,

FOR WATER AND GAS,

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RILEY A. BRICK.
W. W. CAMPBELL.

Brooklyn Clay Retort

AND

FIRE-BRICK WORKS,

VAN DYKE STREET, BROOKLYN, N. Y.

EDWARD D. WHITE, Surviving Partner of the late firm J. K BRICK & CO. 402-1y

TO GAS COMPANIES.

FOR SALE, IN LOTS TO SUIT.

TWO HOLDERS—one with Iron Columns and Girders.

HYDRAULIC (4 inch) STAND PIPES, MOUTH PIECES and Covers for two benches of Threes.

Three IRON RETORTS—Condensers, Washer and Washer Tank.

Three Round (4 feet) PURIFIERS and Covers, with Center Seal and connections Station Meter and several Dry Meters Apply at the office of this Journal. 412

WREN'S GAS WORKS.

Corner of Jay and Water Streets,

BROOKLYN, N. Y.

HAVING GRANTED THE USE OF ONE OF my Patents to the Gas-Light Company of America, and settled my claim against them, I inform the profession that I continue to erect Works and sell Licenses to use my Patents for making Gas from Petroleum.

You can enrich your Coal Gas to any desired standard, by using my process, in the simplest manner, and much cheaper than by *any other* method.

397 W. C. WREN.

OFFICE OF THE

NATIONAL COAL GAS COMPANY,

No. 4 Warren Street, New York.

H. P. ALLEN, President.
I. B. BRICE, Vice-President.
A. H. ALLEN, Secretary.
WM. J. VALENTINE, Treasurer.
GEORGE W. HARRIS. Engineer.

This Company is the owner of the GWYNNE-HARRIS, or AMERICAN HYDROCARBON process, for making Gas for Lighting or Heating purposes, by the perfect decomposition of superheated steam, under what is known as the

GWYNNE AND HARRIS PATENTS.

This process has been fully tested nearly 50,000,000 cubic feet of Gas having been made under it, and fully demonstrating the fact that it is the greatest improvement ever made in the manufacture of Gas, either for Lighting or Heating purposes. With half a ton of Anthracite Coal 150,000 cubic feet of Gas per day is made from three benches, and the labor is so small that one man can attend three or four benches.

The process can be put into either Coal or Oil Gas Works (or where both Coal and Oil are used) at small cost, without any interruption to the working of other benches. The Citizens Gas-Light Company of Brooklyn, after using it for more than seven months, have found it not only far better, but actually *cheaper* than atmospheric air in making Gas, with the use of "petroleum and its products"

Further information, and terms of sale of rights will be given, upon application to the Company 348-1y

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American Meter Co.—West 22nd st., N. Y,. Arch and 22nd street, Phila.
Cast Iron Gas and Water Pipe—S. Decatur Smith, York and Moyer streets, Phila., Pa.
Cast Iron Gas and Water Pipes—R. D. Wood & Co., Philadelphia Pa.
Cast Iron Gas and Water Pipe—McNeals & Archer, Burlington, N. J.
Clay Gas Retorts, etc.—Gardner Bros., 96½ Fourth Avenue, Pittsburgh, Pa.
Cast-Iron Pipes and Fittings—B. S. Benson, 52 East Monument street, Baltimore, Md.
Cast Iron Pipes for Water and Gas—Campbell Brick, & Co., 112 Leonard street, N. Y.
Cast Iron Gas and Water Pipe, etc.—H. R. Smith & Co., Columbus. Ohio.
Gas Valves (Chapman) 75 and 77 Kilby st., Boston, Mass.
Gas-Burners—C. Gefrorer, 248 North 9th st., Phila. , Pa.
Gas Purification—St. John and Cartwright, 21st and Avenue A, New York.
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Gas Meters, etc.—Wm. W. Goodwin & Company, 1012 Filbert street, Phila, Pa.
Gas Meter Manufacturers—Harris, Helme & McIlhenny, 1117 Cherry st., Philadelphia, Pa
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Gasholders, Etc.—Deily & Fowler, 39 Laurel st., Phila., Pa.
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Gasholders—George Stacey & Co., Ramsay st., Cincinnati, O.
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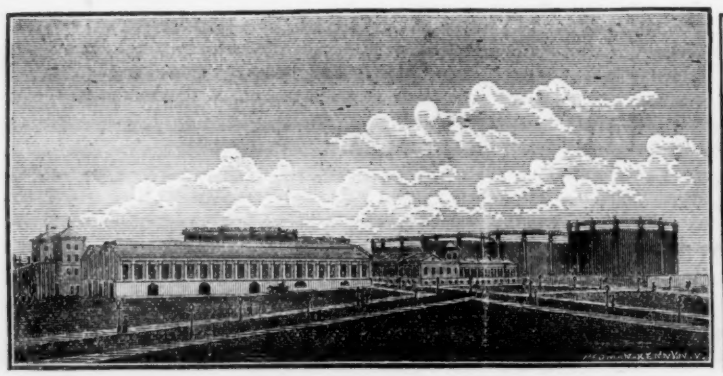
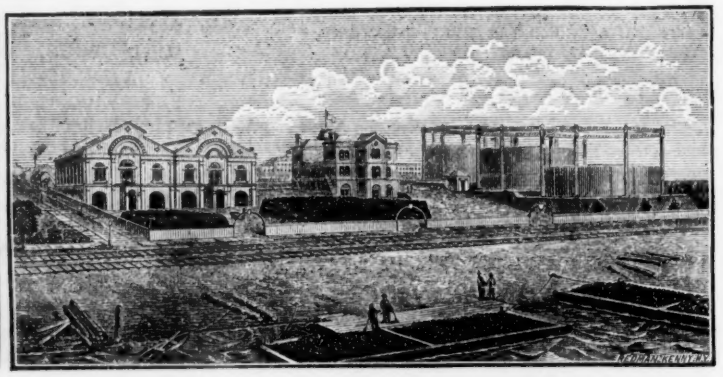


CINCINNATI GAS WORKS. ERECTED 1871-72-73.—WM. FARMER, ENG.



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Exhausters for Gas and Foul Lime Ventilation,
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THE GAS-LIGHT COMPANY OF AMERICA, owners of the Patent Processes for making ILLUMINATING GAS from PETROLEUM and its products, known as the

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AND
Wren and Barker Patents,

are prepared to treat with Gas Companies and Manufacturers of Gas for the use of said processes.

An examination of the merits of these inventions as demonstrated by practical experience in a large number of Gas Works employing them, will not fail to convince the intelligent Gas Manufacturer of the great advantages derived from their use.

Gas of unexceptional quality, of high illuminating power is made at many of these works by these processes, at a cost of from 40 per cent. to 60 per cent. less than an ordinary quality of illuminating gas can be made by any other methods in use. Gas Companies generally may easily, and at small outlay for making the necessary changes in manufacturing apparatus, double their net earnings, and supply a much better light to their patrons, at greatly reduced prices.

The Company respectfully refer to Companies using these processes in this city, Reading, Penn., Chicago and elsewhere, and especially to the Mutual Gas-Light Company of Detroit Mich., whose works more nearly conform in all details of construction to the original plans of the inventors, than those of other Companies.

For Correspondence, etc., address to office as above.

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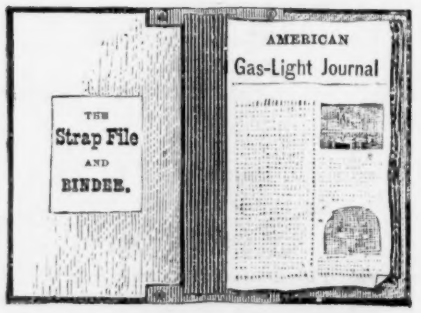

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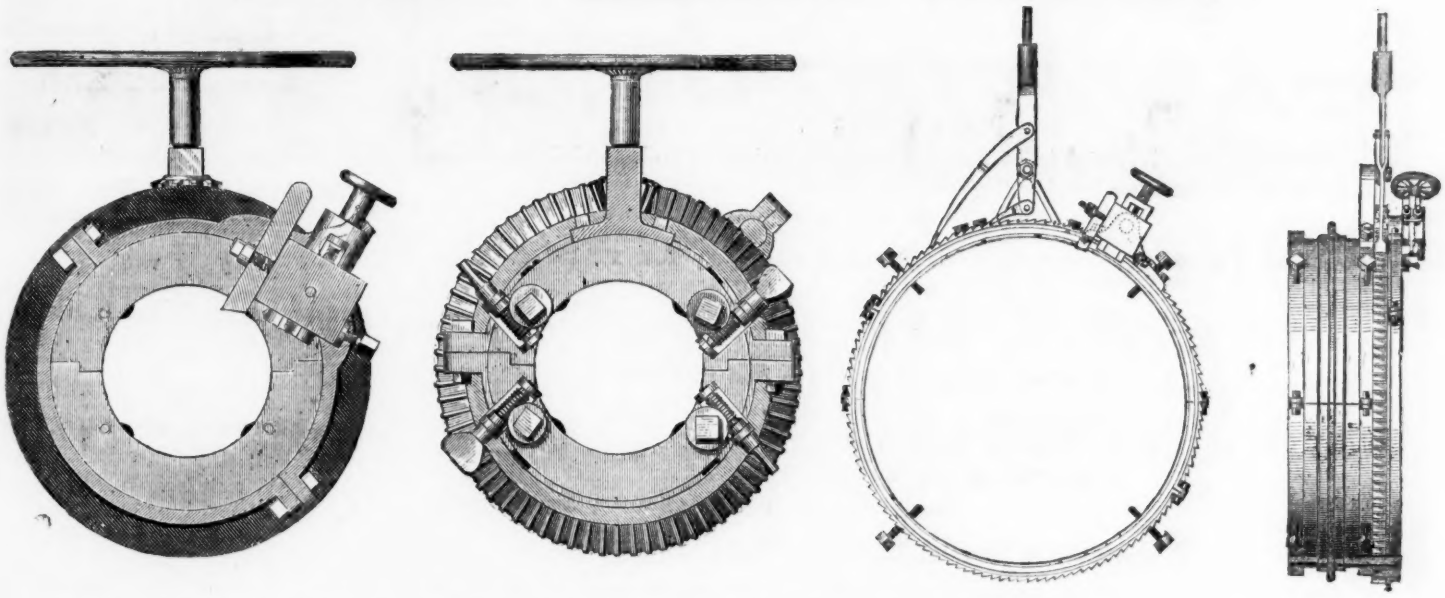
CAST IRON PIPE.



It will cut Cast or Wrought Iron Pipe, Shafts, or Columns of any size, making a clean, smooth, and square cut.

A Continuous Line of Pipe in a Trench or Building

cut, as well as Loose Pipe.

Our Machines for cutting 30-INCH PIPE have been furnished to the Manhattan and New York Gas Light Companies, and operate to their entire satisfaction. The smaller sized Machines have been in practical use for more than a year, with the most satisfactory results. For further information address

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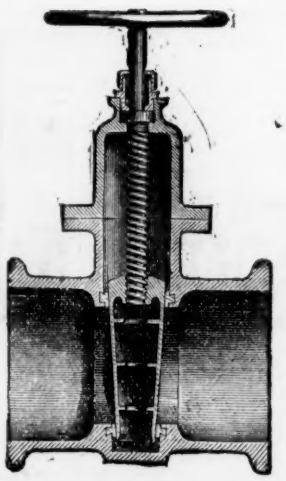

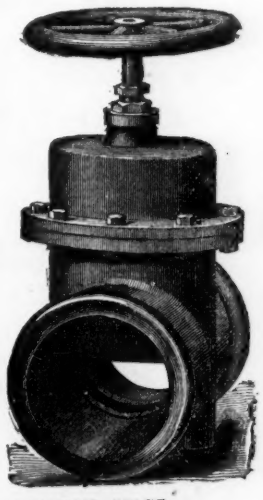

These Valves have been in use for several years, and are pronounced by all who have used them to be

The Best Gas Valves Ever Made.

They afford a direct passage the full size of the pipe. The seats are made of an alloy similar to BABBITT metal, specially prepared for the purpose, and superior to all other metals used for the seats of Gas Valves. It does not corrode under any circumstances to which it is exposed.

There is no LIABILITY OF COHESION between the Gate and Seat, and the Valves can be relied upon to SHUT TIGHT and OPEN EASILY at all times—an important desideratum when used for street mains, in cases of fire.

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NEWTON & WATERTOWN GAS-LIGHT CO., WATERTOWN, MASS.
LAWRENCE GAS-LIGHT COMPANY, LAWRENCE, MASS.
PEOPLES GAS-LIGHT COMPANY, BROOKLYN, N. Y.
CITIZENS GAS-LIGHT COMPANY, BROOKLYN, N. Y.
SOUTH BOSTON GAS-LIGHT COMPANY, BOSTON, MASS.
CHARLESTOWN GAS-LIGHT CO., CHARLESTOWN, MASS.
LYNN GAS-LIGHT COMPANY, LYNN, MASS.
FITCHBURG GAS-LIGHT COMPANY, FITCHBURG, MASS.
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GAS AND WATER VALVES ½ INCH TO 36 INCHES DIAMETER.

STEAM VALVES ½ INCH TO 12 INCHES DIAMETER.

857-tf

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THE

PENN GAS COAL COMPANY

OFFER THEIR

COAL, CAREFULLY SCREENED,

AND PREPARED FOR

GAS PURPOSES.

Their Property is located in the Youghiogheny Coal Basin, near Irwin's and Penn Station, on the Pennsylvania Railroad, and on the Youghiogheny River.

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366-1y

CANNELTON COAL CO.

OF WEST VIRGINIA.

Offer for sale the following Coals, from their Colliery at CANNELTON, Kanawha County, West Virginia, delivered at RICHMOND, Va.:

CANNELTON CANNEL,

acknowledged to be the most valuable ENRICHER produced in this country, a gross ton yielding 10,000 ubic feet of GAS of 64·54 CANDLE POWER; COKE 32 bushels, of good quality.

CANNELTON CAKING COAL.

Volatile Matter.	Coke.	Per cent. of Ash in Coal.	Per cent. of Ash in Coke.	Sulphur in Coke.	Sulphur in Ootl.	Sulphur in Volatile Matter.	Specif. Gravity. Coal.	Specif. Gravity. Gas.
35.1	64.9	2	6	.82	1.48	.66	1.289	.476

MAXIMUM YIELD, 5.06 cubic feet of Gas per pound of Coal—A yield of 4·78 cubic feet per lb.—gave 16 14-100 Candle-Power.

COKE, of very fine quality—1453 pounds produced from one ton of coal.

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THE WAVERLY COAL AND COKE CO.

Offer for Sale the

YOUGHIOGHENY COAL

DOUBLE SCREENED,

from their Colliery at Smith's Mills, on the Youghiogheny River, thirty-seven and a half miles southerly of Pittsburgh. This Coal has the preference in Pittsburgh over all other YOUGHIOGHENY COAL for GAS PURPOSES.

The facilities of the WAVERLY COMPANY are unsurpassed by those of any other Company on the Youghiogheny.

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CHAS. H. MEYER & CO.,

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LAVA TIPS AND SCOTCH TIPS.

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For the Sale and Distribution of the Superior

Cannel, Splint, Gas and Steam

COALS,

FROM THE

Kanawha & New River Coal Regions

ON THE LINE OF THE

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426-6t

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351-1y

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CANNEL COAL

From West Virginia.

Yields over 13,000 feet of Gas per ton. At ten thousand feet (standard yield) the illuminating power is over 43 candles. Purifies 4,510 feet to the bushel of lime.

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IMPROVED GAS EXHAUSTER,

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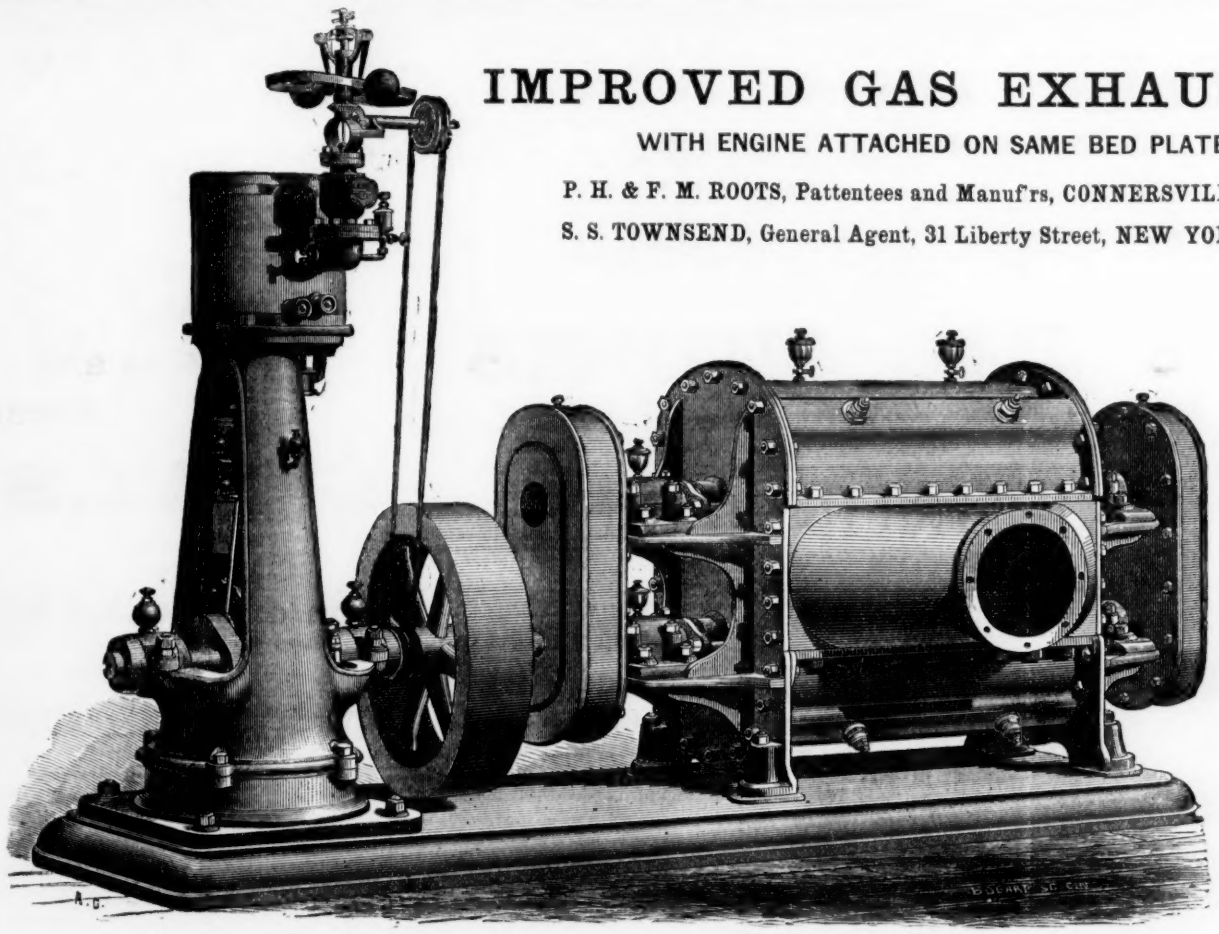

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Best dry coals shipped from Locust Point, wharves, and prompt attention given to orders for chartering of vessels.

924-1y n

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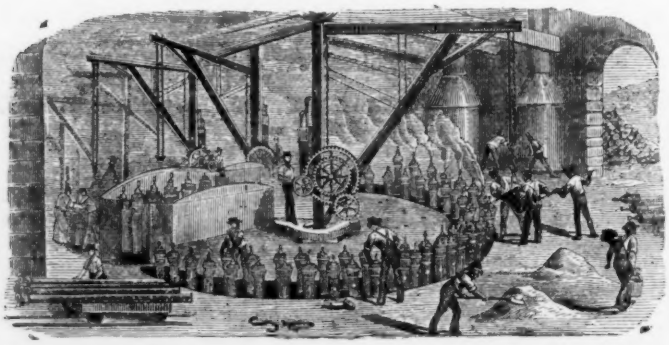

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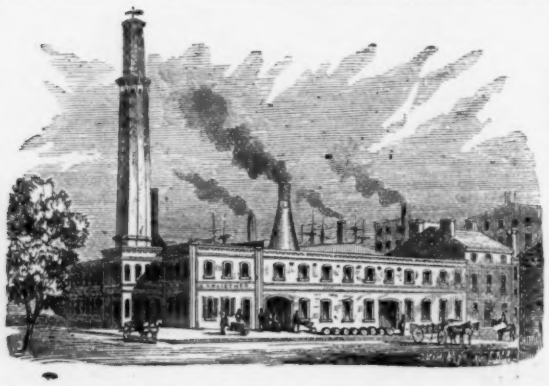

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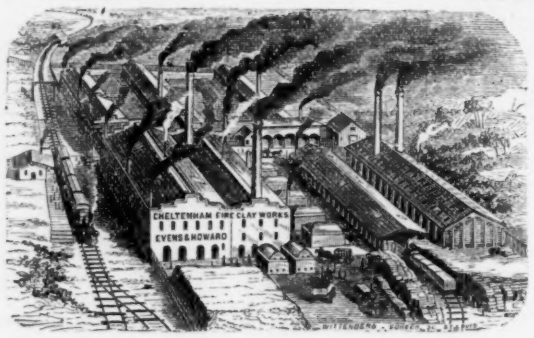

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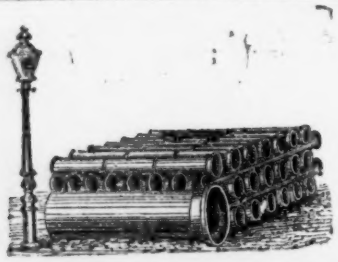

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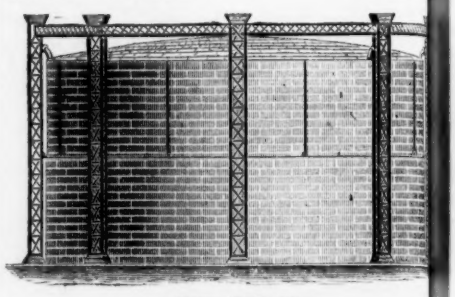

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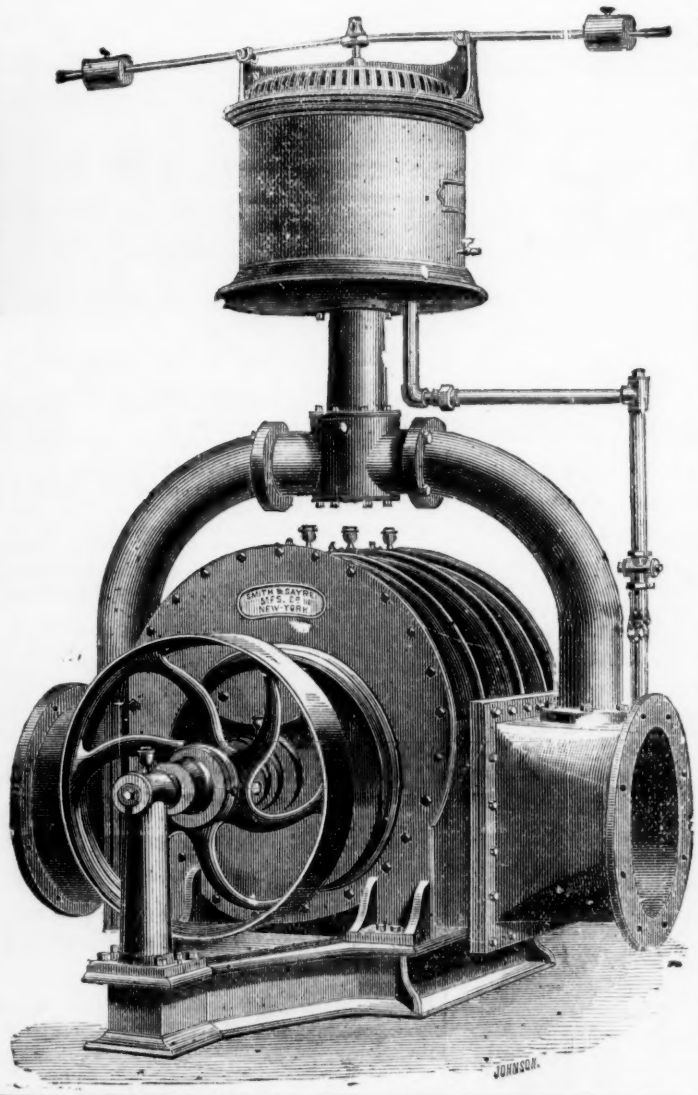

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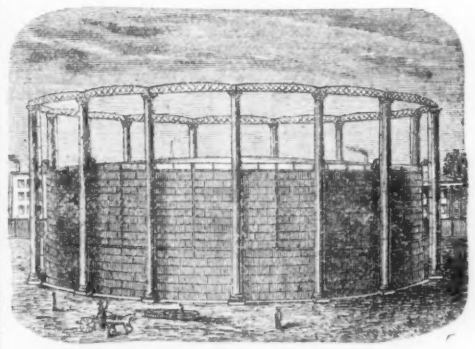

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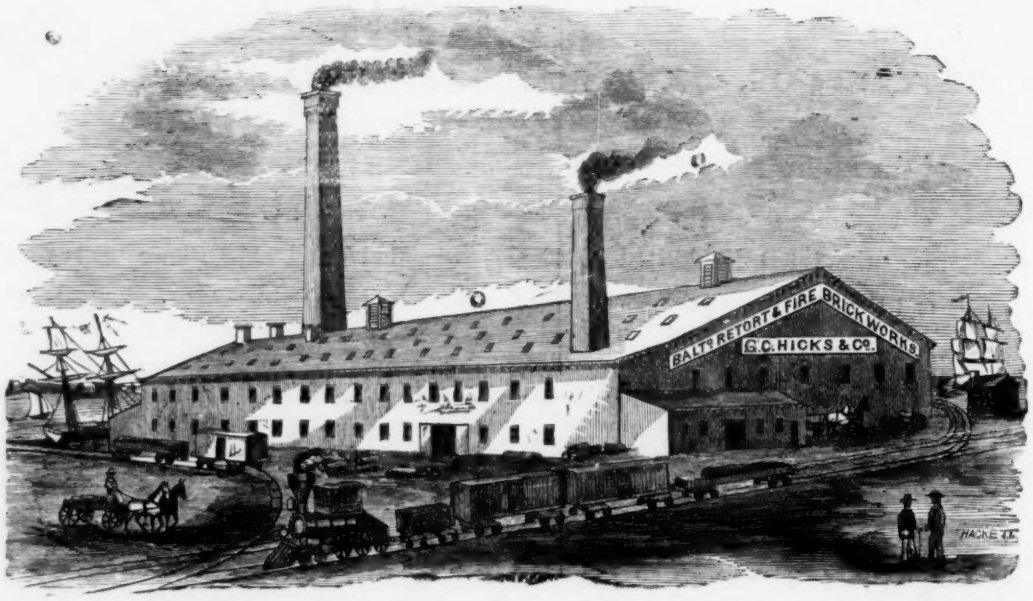

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"Among the letters which you placed in my hands for examination regarding the general standing of your fire clay, gas retorts, and gas furnace, bricks, &c., there were a number from the leading gas manufacturers of the U. S., speaking in the highest possible terms of their durability, freedom from the accumulation of condensed carbon, and general excellence. I regret that these letters are mislaid, or still remain in the Judges' room at the Centennial. I suppose you are aware that your retorts were awarded a First Premium at the Centennial.

"Yours truly, E. T. COX," *of the Centennial Jury of Awards.*